

An Account of the Species of the Red Alga *Herposiphonia* Occurring in the Central and Western Tropical Pacific Ocean

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ABSTRACT: Fourteen species of the genus *Herposiphonia* are described. The following species and varieties are new: *H. arcuata*, *H. crassa*, *H. delicatula*, *H. dendroidea*, *H. dendroidea* var. *minor*, *H. dubia*, *H. nuda*, *H. obscura*, *H. parca* var. *interrupta*, *H. pacifica*, *H. trichia*, *H. variabilis*. The distributional range is extended for *H. parca*, *H. subdisticha*, and *H. tenella*. *H. secunda* is reduced to a form of *H. tenella*.

Emphasis is given to the nature and arrangement of trichoblasts and of sexual reproductive structures as features of taxonomic importance.

THE GENUS *Herposiphonia* was established by Nägeli (1846). *H. tenella* is generally considered the type species, although no binomials are cited by Nägeli. The name *Herposiphonia* was also used by Kuetzing (1843:417) for a group of species of *Polysiphonia*, including *P. tenella* (*Hutchinsia tenella* of C. Agardh 1828: 105). Hence, *Herposiphonia* (Kuetzing) Nägeli appears to be the basis for lectotypification of the genus by Schmitz (1889), with *H. tenella* as the type species.

The basic features of the genus have been described in considerable detail by Falkenberg (1901) and by Boergesen (1918). Approximately 30 species have been previously described.

The most distinctive features of the genus are the dorsiventral construction and the more or less regular sequence of exogenous determinate branches and indeterminate branches. In the basic pattern of branching, indeterminate branches arise on alternate sides of the axes at intervals of four nodes, with determinate branches alternating on either flank at the intervening nodes, and with the most distal determinate branch on the same side as the next indeterminate branch distally. In most species the indeterminate branches usually remain small or rudimentary. The determinate branches are simple in most species, but are branched in a few species. The apex of indeterminate branches is usually inrolled away from the substratum, the determinate branches commonly arching

toward the apex of the related indeterminate branch. The branches are never corticated. In certain species the chromatophores are commonly arranged in transverse bands in the pericentral cells on the side toward the central cell. Rhizoids always arise from the distal end of ventral pericentral cells, most commonly one per segment. They are cut off from the pericentral cell by a curving wall.

Trichoblasts and reproductive structures arise exclusively on the determinate branches. The sequence of determinate and indeterminate branches, commonly considered a dependable taxonomic feature, seems to be reliable for most species, but not for certain species. The relative number and nature of the trichoblasts, and the number of segments in determinate branches, as well as the number of pericentral cells, are features usually characteristic for a given species, although there is often considerable variation, especially in the number of segments in the determinate branches and the degree of development of the trichoblasts. The nature and position of fully mature trichoblasts is, in the opinion of the writer, a fairly dependable taxonomic feature. Also, the number of segments developing in determinate branches beyond the first formed trichoblast is usually significant.

Probably one of the most important taxonomic features is the nature and position of the reproductive structures, especially the sexual reproductive structures, although, unfortunately, the latter are infrequently found. Tetrasporangia always arise one per segment in normally

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straight series on the side of the branches away from the apex of the axis bearing the branch.

The following symbols indicate the chief collectors of the materials studied: D., Maxwell S. Doty, University of Hawaii; G., Malvern Gilmartin, Jr., at the time at the University of Hawaii; H., G. J. Hollenberg; Ha., H. E. Hackett of Duke University; H., T., and B., G. J. Hollenberg, Roy Tsuda, and Richard Buggeln; L., C. R. Long, a graduate student at the University of Hawaii, and T., Roy Tsuda, a graduate student at the time at the University of Hawaii, along with Richard Buggeln. All "D" collections were made by Maxwell S. Doty unless otherwise indicated. The notation "(N.Y.*)" indicates collections examined at the New York Botanical Garden.

The areas represented in the study are mostly those represented in a previous report on species of *Polysiphonia* from the central and western tropical Pacific Ocean (Hollenberg, 1968). The areas are treated in the same order as in that report. Although they are not within the main areas represented by the study, it seemed best to include certain collections from the western Atlantic Ocean. Also included are collections by H. E. Hackett (Ha.) in the Maldive Islands ($6^{\circ}55'N$ to $0^{\circ}41'S$, $72-73^{\circ}34'E$), on cruise 8 of the TE VEGA International Indian Ocean Expedition, 1964. The geographic location of the main collection areas is given in the report on *Polysiphonia*.

Type material will be deposited in the Smithsonian Institution, Washington, D.C. Isotypes

KEY TO THE SPECIES OF *Herposiphonia*

1. Determinate branches subdistichous *H. subdisticha*
1. Determinate branches not subdistichous 2
2. Mostly with a determinate or an indeterminate branch or branch primordium on every segment 3
2. Mostly with one or more segments between successive indeterminate branches without a branch of either type 11
3. Trichoblasts and scar-cells lacking, except for scar-cells at the former point of attachment of spermatangial branches *H. nuda*
3. Trichoblasts or scar-cells present, the trichoblasts sometimes very rudimentary 4
4. Trichoblasts infrequent and very rudimentary *H. dubia*
4. Trichoblasts and/or scar-cells frequent to abundant, mostly well developed 5
5. Trichoblasts unbranched *H. trichia*
5. Trichoblasts branched 6
6. Trichoblasts and/or scar-cells not more than 2 per branchlet, strictly terminal, with a percurrent axis and 7 or more laterals; scar-cells large *H. dendroidea*
6. Trichoblasts and scar-cells otherwise 7
7. Determinate branches composed of 40-55 segments; trichoblasts 6 or more, one per segment on the branch tips *H. filifera*
7. Determinate branches composed mostly of fewer than 30 segments; trichoblasts mostly 2-3 at branch tips 8
8. Diameter of mature determinate branches mostly 100-140 μ , with about 14 pericentral cells ... *H. crassa*
8. Diameter of mature determinate branches mostly less than 80 μ ; pericentral cells mostly 12 or fewer ... 9
9. Procarps and spermatangial stichidia strictly terminal; trichoblasts 2-3, terminal *H. parca*
9. Cystocarps and spermatangial stichidia not terminal 10
10. Sexual reproductive structures borne 3-10 segments from the branch apex at maturity *H. tenella*
10. Sexual reproductive structures borne mostly on the lower half of the determinate branch .. *H. delicatula*
11. Most of the indeterminate branch primordia arrested at the few-celled stage *H. obscura*
11. All indeterminate branches developing to obvious, although often small branchlets 12
12. Most of the indeterminate branches developing into conspicuously branched laterals; main axes commonly growing free from the substratum in terminal parts *H. arcuata*
12. Most of the indeterminate branches remaining rudimentary or small 13
13. Central cells of determinate branches conspicuously larger than the pericentral cells 14
13. Central cells of determinate branches not conspicuously larger than the pericentral cells 15
14. Determinate branches mostly less than 1 mm high and composed of fewer than 30 segments .. *H. variabilis*
14. Determinate branches commonly 10-15 mm high and composed of 50-70-(90) segments ... *H. pacifica*
15. Determinate branches mostly 35-50 μ in diameter, composed of 12-14 segments; procarps and spermatangial stichidia arising mostly on the basal half of the determinate branches *H. delicatula*
15. Determinate branches mostly 60-100 μ in diameter, composed of 16-18-(30) segments; procarps and spermatangial stichidia arising terminally or in the upper half of the branches; spermatangial stichidia with a short sterile tip *H. tenella* form *secunda*

or syntypes and many glucose slide mounts of various species will be stored at the University of Hawaii.

ACKNOWLEDGMENTS

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The material collected by C. R. Long was collected under the auspices of the Pacific Ocean Biological Survey Program conducted by the Division of Birds, Smithsonian Institution.

Herposiphonia arcuata sp. nov.

Fig. 5

Densely branched algae, forming extensive patches mostly on other algae; main axes commonly growing free from the substratum, and most of the indeterminate branches developing into laterals of varying lengths; indeterminate branches 140–190 μ in diameter, with segments 1.0–1.5 diameters long; determinate branches morphologically erect, arising mostly at intervals of 3 segments, alternately on either flank, followed by an indeterminate branch on the same side, but more lateral in position; mostly 1 but frequently 2 or more nodes without a branch occurring between an indeterminate branch and the next distal determinate branch; determinate branches composed of 10–12–(20) segments, 1.0–2.0 diameters long, strongly arched distally, and mostly remaining slightly arched when mature; pericentral cells mostly 10, slightly smaller than the central cells; chromatophores non-zonate; walls brownish, relatively firm; trichoblasts usually 2–3 per determinate branch, usually poorly developed, but sometimes up to 1.7 mm long, with 4–6 dichotomies; tetrasporangia 60–75 μ in diameter, in series of 4–6 in the middle or terminal parts of the branches; cystocarps ovate to globular, to 300 μ in diameter, arising terminally on the 6th to 9th segment, the branch

growing beyond the developing cystocarp 8–9–(15) segments and bearing in succession 5 or more trichoblasts spirally arranged; spermatangial stichidia 160–175 μ long, 50–65 μ broad, mostly one per segment in spiral sequence on 8–12 short terminal segments, each arising as a primary fork of a trichoblast, and terminating in a sterile tip of 1–2 short cells, quickly deciduous.

Algae ramosissimae, maculas amplas in saxis et in algis aliis formantes; partes distales ramorum principalium a substrato plerumque discretae crescentes; plerique ramuli indeterminati in ramulos laterales longitudine variantes evolventes; ordinatis ramificationis unum nodum sine ramis et unicum ramum determinatum dorsilateralem inter ramos indeterminatos plerumque praebens; rami determinati e 10–12 segmentis 1.0–1.5 plo longioribus quam latis, versus extremitatem distalem rami fertillis valde arcuatis plerumque compositi; cellulae pericentrales plerumque 10; chromatophora non zonata; trichoblastae plerumque duae, usque ad 1.3 mm long., 4–5 dichotomias habentes; tetrasporangia 60–75 μ diam., 4–6 continua; cystocarpi ovati ad fere globularos, ad 300 μ diam., terminaliter orientes, ramo 8–10 segmenta ultra cystocarpum evolventem formante; stichidia spermatangialia 160–175 μ \times 50–65 μ , cacumen sterile, ex una ad duas cellulas breves constans, habentia, saepissime unum spermatangium in omni segmento in spira in 8–10 segmentis terminalibus brevibus, omne spermatangium ut furca primaria trichoblastae oriens, mox, autem, deciduum.

TYPE COLLECTION: D. 19611, tetrasporic, cystocarpic, spermatangial, awash at Kailua, Oahu, Hawaii, legit M. S. Doty and H. B. S. Womersley, Jan. 21, 1962. It is represented by two glucose slide mounts and considerable fluid-preserved material.

ADDITIONAL COLLECTIONS EXAMINED: HAWAIIAN ISLANDS:—D. 13019, on reef, Koloa, Oahu, Oct. 30, 1955; D. 13039A, cystocarpic, on *Griffithsia* sp., and D. 13051, on *Sargassum* sp., both awash, Kailua Beach Park, Oahu, Nov. 27, 1955; D. 17110, cystocarpic, on *Sargassum* sp., near the Natatorium, Waikiki, Oahu, Nov. 20, 1958; D. 20050.1, tetrasporic, spermatangial, on other algae, wave-battered shore, Laie, Oahu, legit R. Tsuda, R. Buggeln, and G. Trono, May 5, 1963; D. 20224, tetrasporic, awash, Kailua Beach Park, Oahu, Nov. 14, 1965; an unnumbered collection by M. Kajimura, tetrasporic, on *Sargassum* sp., Sans Souci

Beach, Waikiki, Oahu, Dec. 26, 1964; an unnumbered collection by G. Trono, on *Sargassum* sp., near the outer reef margin, Kaaawa, Oahu, Nov. 28, 1964; D. 19823.1, on *Laurencia* sp., Halena, Molokai, Dec. 28, 1953; MARSHALL ISLANDS—H. 48-0914.19, on *Pocockiella* sp., on reef, Uku I., Bikini Atoll, July 9, 1948; CAROLINE ISLANDS—D. 23756.4, in algal turf, on reef, Quoi I., Truk group, legit Ernani Meñez, Aug. 2, 1960.

This species seems closest to *H. pecten-veneris* Harvey (1853) as described by Taylor (1960), especially in the free-growing branches, with most of the indeterminate branches developing as lateral axes. It differs from Taylor's description in several respects: (1) somewhat more densely branched with less extensive free branches, and mostly shorter segments in the indeterminate branches; (2) mostly with one or more bare nodes between successive branches, seemingly not a feature of *H. pecten-veneris*; (3) mostly more numerous and longer segments in the determinate branches, especially branches bearing mature cystocarps; (4) the apices of indeterminate branches strongly curved as in *H. pecten-veneris*, but the convex side morphologically ventral rather than dorsal as described by Taylor.

Herposiphonia crassa sp. nov.

Figs. 12, 13

Relatively coarse, densely branched algae, attached by numerous unicellular rhizoids, mostly with digitate tips, with 3 erect determinate branches between successive indeterminate branches and with no bare nodes; prostrate branches 240–300 μ in diameter, with about 12 pericentral cells and with segments mostly shorter than broad; indeterminate lateral branches mostly remaining very short; determinate branches simple. Diameter, 100–140–(200) μ at the base and mostly narrower above, with a blunt apex, with 14–18 pericentral cells and composed of 8–9 segments, mostly about 1 diameter long; chromatophores not zonate; trichoblasts 2–3, the first one formed mostly one segment from the apex, followed by 1 or often 2, on reduced terminal segments, which are displaced slightly toward the distal end of the related indeterminate branch; trichoblasts coarse,

up to 1.7–(2.4) mm long and 60 μ in diameter at the base, with 6–7 forks and rounded apices 10–11 μ in diameter; young trichoblasts with an evident percurrent axis composed of 6–7 spherical cells, with laterals in two longitudinal rows on the distal side relative to the related indeterminate branch, the percurrent axis of the trichoblast not evident at maturity; tetrasporangia about 65 μ in diameter, in straight series of 4–6 in the middle portion of determinate branches. Sexual plants unknown.

Algae praecipue caespiticiae, tres ramos determinatos erectos inter ramos indeterminatos successivos habentes; rami prostrati 240–300 μ diam.; rami determinati 140–200 μ diam. ad basim, manifeste angustiores supra, ex 8–9 segmentis plerumque aequae longis ac latis compositi; trichoblastae 2–3, grossae, prima in segmento infra apicem, deinde una duaeve in segmento terminali reducto, ad latus versus apicem rami fertilis summoto, orientibus; trichoblastae ad 2.4 mm long.; 6–7 furcas habentes; tetrasporangia 4–6 continua in parte media ramorum nata.

TYPE COLLECTION: D. 22538, tetrasporic, abundant on boulders, Kahakuloa Bay, Maui, Hawaii, legit H., T., and B., April 21, 1965. This collection is represented by 3 glucose slide mounts and fluid-preserved material.

ADDITIONAL COLLECTIONS EXAMINED: HAWAIIAN ISLANDS—D. 8931.1, on *Laurencia* sp., on wave-swept rocks, Laie, Oahu, Oct. 27, 1951; D. 10385.1, tetrasporic, on *Codium* sp., at a depth of 5 ft, Kaaawa, Oahu, legit George Ikeda, Feb. 3, 1952; D. 17242.3, Halona, Oahu, legit Jessie Kajiwara, Nov. 14, 1956; D. 17415.1, on *Hypnea* sp., Kukaimanini Rock, Oahu, Mar. 17, 1959; D. 20048.1, on *Laurencia* sp., wave-battered shore, Laie, Oahu, legit R. Tsuda, G. Trono, and R. Buggeln, May 5, 1963; H. 65–67, in algal turf, low littoral, Wawamalu Beach, Oahu, May 1, 1965; an unnumbered collection by M. Kajimura, Hanauma Bay, Oahu, Mar. 27, 1965; D. 22383.3, 22388, 22390, 22398, all in algal turf, basalt shore 0.5 mile southwest of Maalaea, Maui, legit H., T., and B., Apr. 19, 1965; D. 22401.2, in algal turf, intertidal basalt shore, Papawai Point, northwest of Maalaea, Maui, legit H., T., and B., Apr. 21, 1965; D. 22410, 22410.6, in algal turf, near McGregor Point, Maui, legit H., T., and B., Apr. 19, 1965; D. 22533.2, tetrasporic, in

algal turf on boulders, Honokohau, northern Maui, legit H., T., and B., Apr. 20, 1965; Ha. 30-2Q-17A, on *Dictyota* sp., Bushy Island, Addu Atoll, Maldive Islands, May 10, 1964.

This species is close to *H. parca*, from which it differs chiefly in being much coarser, with more numerous pericentral cells, mostly shorter segments, tapering determinate branches, and coarser trichoblasts. It is also characteristically saxicolous, whereas *H. parca* is usually epiphytic.

Herposiphonia delicatula sp. nov.

Figs. 1A, 1B, 2H, 3

Epiphytic algae, with indeterminate prostrate branches mostly 35–40 μ in diameter, composed of segments 1–2 diameters long, with 7–8 pericentral cells, attached by rhizoids with digitate and frequently multicellular tips; determinate branches erect, in alternating series of three between successive alternating, indeterminate branches, which mostly remain short; erect branches 30–40 μ in diameter, composed of 12–14–(30) segments 1.0–1.5 diameters long or occasionally longer, with 6–8 pericentral cells; chromatophores commonly zonate; trichoblasts 3–4, terminal, with 1–3 dichotomies, mostly poorly represented, but occasionally as much as 700 μ long, with a basal cell up to 250 μ long and 20 μ in diameter; tetrasporangia in series of 5–8 in the lower or middle part of the branches; procarps arising on the 4th to 6th segment from the base of the branches; cystocarps not observed; spermatangial stichidia lanceolate, about 80 μ long, and 25 μ in diameter, arising on the convex side of the branches 3–5 segments from the base or sometimes nearer the apex, without a sterile tip.

Algae epiphyticae ramos prostratos plerumque 35–40 μ diam. habentes, cellulis pericentralibus 7–8; rami determinati erecti, tribus in positionibus alternantibus inter ramos indeterminatos successivos sitis, 30–40 μ diam., e plerumque 12–14 segmentis 1.0–1.5 plo longioribus quam latis compositis, cellulis pericentralibus 6–8; trichoblastae 3–4, terminales, 1–3 dichotomias habentes, plerumque parum evolutae, interdum, autem, usque ad 700 μ long., cellula basali usque ad 250 μ long.; tetrasporangia 5–8 continua, in partibus inferioribus mediisve ramorum nata; procarpi in segmento quarto vel sexto a basi ramorum orientes; cystocarpi non observati; stichidia spermatangialia lanceolata, 80 \times 25 μ , uno vel duobus in

latere convexo ramorum in segmento tertio ad quinto a basi natis, sine cacumine sterile.

TYPE COLLECTION: D. 21876.1, tetrasporic, cystocarpic, spermatangial, on *Amphiroa* sp., on a reef at Falas Island, Truk group (7° 32' N, 151° 45' E), Caroline Islands, legit E. Meñez, Aug. 1960. This collection is represented by three glucose slide mounts.

ADDITIONAL COLLECTIONS EXAMINED: HAWAIIAN ISLANDS—D. 19135Z3, tetrasporic, dredged at 26 fa in front of the river mouth, Waialua, Oahu, Aug. 2, 1959; MARSHALL ISLANDS—H. 48-1213.71, Amen I., Bikini Atoll, July 7, 1948; CAROLINE ISLANDS—all legit E. Meñez, D. 15126.1, on *Amphiroa* sp., on a reef at Tafansak Village, Kusaie I., July 16, 1960; D. 23261.2, on *Halimeda* sp., Falas I., D. 23438.2, tetrasporic, cystocarpic, on *Amphiroa* sp., Moen I., D. 23444.1, tetrasporic, on *Amphiroa* sp., from a reef at Falas I., July, 1960; D. 23471.2, tetrasporic, on a jointed coralline, on a reef at Yap I., Aug. 18, 1960; PHILIPPINE ISLANDS—D. 18099C, tetrasporic, on *Sargassum* sp., Davao, Mindanao, June 22, 1958; MARIANA ISLANDS—D. 20129, spermatangial, 20130, on *Sargassum* sp., Guam, legit E. Meñez, Oct. 12, 1960; MALAYSIA—D. 18179, on *Thalassia*, floating in a channel between Tanjung, Penang and Singapore, Oct. 29, 1957; MALDIVE ISLANDS—Ha. 9-2E-121-33B, on *Dictyota* sp., is doubtfully referred to this species. It was collected from the channel between Maro and Mafilefuri, Fadiffolu Atoll, Mar. 24, 1964; WESTERN ATLANTIC OCEAN—a collection by Louis G. Williams, No. 247, on *Codium* sp., from Shark Shoal Jetty, Beaufort, North Carolina, July 25, 1949, identifies readily with *H. delicatula*, differing chiefly in the number of segments in the determinate branches, as many as 40 segments being counted. The material is cystocarpic, with procarps arising in the lower center of the branches, and with mature cystocarps ovoid and about 200 μ in diameter. The number and position of the trichoblasts could not be determined with the material at hand.

This species is closest to *H. tenella*, and like that species exhibits considerable variability of branching pattern, some specimens having no

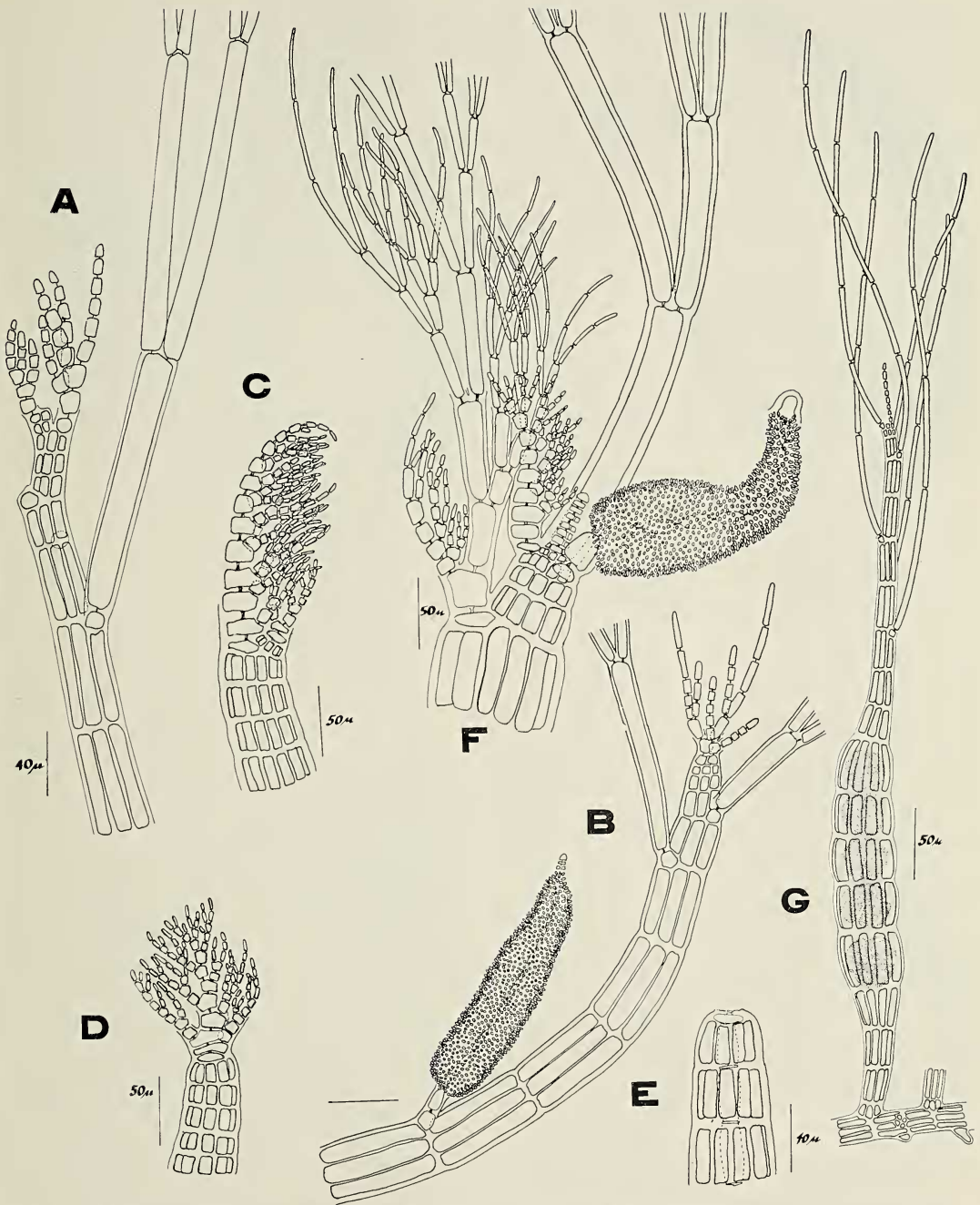


FIG. 1. *A*, *Herposiphonia delicatula*, apex of a determinate branch. *B*, *Herposiphonia delicatula*, upper part of determinate branch bearing spermatangial stichidia four segments from the base. *C*, *Herposiphonia dendroidea*, apex of young determinate branch. *D* and *E*, *Herposiphonia dendroidea*, variant form, with tips of determinate branches, showing single trichoblast and terminal scar-cell respectively. *F*, *Herposiphonia variabilis*, apex of determinate branch with spermatangial stichidium. *G*, *Herposiphonia trichia*, showing tetrasporangia and unbranched trichoblasts.

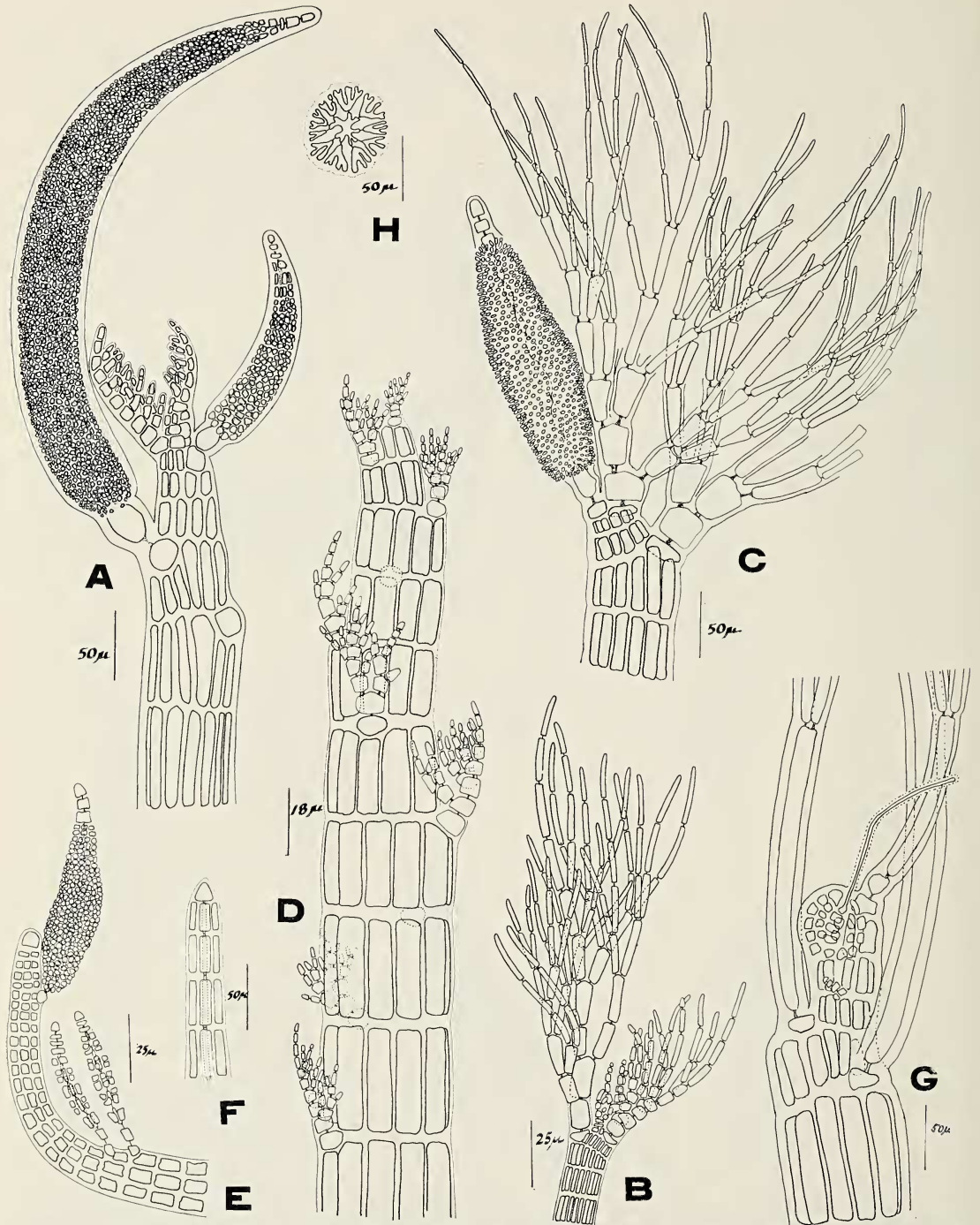


FIG. 2. *A*, *Herposiphonia pacifica*, tip of determinate branch, with spermatangial stichidia. *B*, *Herposiphonia pacifica*, tip of determinate branch, with trichoblasts. *C*, *Herposiphonia parca*, tip of determinate branch, bearing a spermatangial stichidium. *D*, *Herposiphonia filifera*, tip of young determinate branch, with young trichoblasts. *E*, *Herposiphonia nuda*, tip of determinate branch, with young and mature spermatangial stichidia. *F*, *Herposiphonia nuda*, tip of determinate branch. *G*, *Herposiphonia variabilis*, tip of determinate branch, with young cystocarp. *H*, *Herposiphonia delicatula*, tip of multicellular rhizoid seen in end view.

nodes devoid of branches, others having 1–4 bare nodes between successive branches. From *H. tenella* it differs in being more slender, usually with fewer pericentral cells, but differing especially in the position of the sexual structures, which arise mostly in the lower part of the branches rather than in the upper part as in *H. tenella*. Frequently the branching pattern changes in a given branch, so that no bare nodes occur in one portion of a branch, but one to several in another part, a feature reported to occur in *H. tenella* also.

Herposiphonia dendroidea sp. nov.

Figs. 1C, 1D, 1E, 9

Epiphytic or saxicolous algae with prostrate indeterminate branches 95–120 μ in diameter, composed of segments mostly about 1 diameter long, attached by numerous rhizoids with digitate and frequently multicellular tips; 3 determinate erect branches 50–70 μ in diameter in alternating positions between successive alternating indeterminate branches, with usually no bare nodes; pericentral cells 8–10; central cell at least twice the diameter of the pericentral cells; mostly 7–9 segments in determinate branches, with segments mostly less than 1 diameter long; chromatophores zonate; 2 trichoblasts on the determinate branches, one a short terminal one on the much reduced terminal segment, which is slightly deflected in the direction of the apex of the related indeterminate branch, and a much larger one, apparently terminal but in fact subterminal on the second segment from the branch apex; young trichoblasts with a prominent percurrent axis, the larger one 90–100–(800) μ long with 5–6 laterals alternately inserted on the axis, not distichously, but directed, at least in early stages, toward the smaller trichoblast; basal cell of the larger trichoblast up to 240 μ long and 60 μ in diameter at maturity, the percurrent axis becoming obscure; tetrasporangia in straight series in the upper parts of determinate branches; sexual reproductive structures not observed.

Algae epiphyticae aut saxicolae, ramos indeterminatos prostratos 95–120 μ diam., segmentis aequae longis ac latis, habentes; rami determinati tres, nodi nudi inter ramos indeterminatos successivos plerumque nulli; cellulae pericentrales 8–10; plerumque 7–9 segmenta in ramis determinatis, saepissime breviora

quam lata; chromatophora zonata; duae trichoblastae in ramis determinatis, una terminali brevi in segmento terminali multum reducto qui ad apicem rami fertilis indeterminati paululum deflectit, et una multo maiore, ut videtur, terminali, subterminali, vere, autem, in segmento penultimo sita; trichoblastae iuvenes axem percurrentem perspicuum habentes, trichoblasta maior 90–100–(800) μ long., 5–6 ramulis lateralibus praeditae; tetrasporangia in serie recta, in partibus superioribus ramorum determinatorum nata; structurae reproductivae sexuales non observatae.

TYPE COLLECTION: D. 11125.1, tetrasporic, abundant on dead coral beyond the reef ridge, transect area, Ngarumaoa I., Raroia Atoll, Tuamotu Archipelago, legit M. S. Doty and Jan Newhouse, July 8, 1952. This collection is represented by two glucose slide mounts and fluid-preserved material.

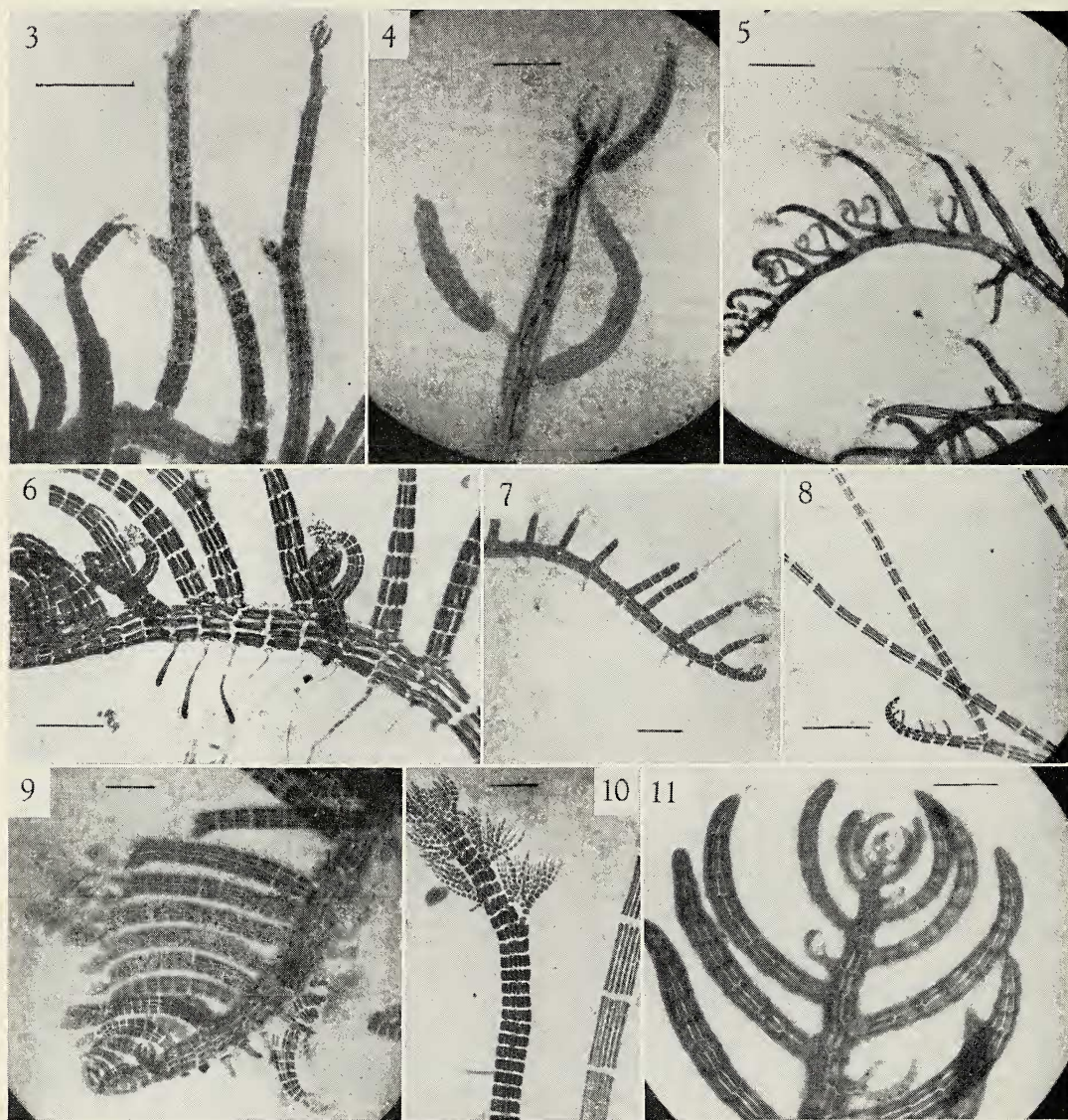
ADDITIONAL COLLECTIONS EXAMINED: PHOENIX ISLANDS—L. 2333.5, on *Dictyosphaeria* sp., Howland I., Oct. 10, 1964; L. 2532.4, in algal turf, north shore of Gardiner I., Oct. 23, 1964; L. 2644.4, on *Halimeda* sp., Birnie I., Nov. 8, 1964; L. 2685.4, in algal turf at a depth of 3 ft, northeast reef, Enderbury I., Nov. 11, 1964; TUAMOTU ARCHIPELAGO—legit M. S. Doty and Jan Newhouse, Raroia Atoll (16° S, 142° 26' W), 1952; D. 11160.4, on dead coral, reef near lagoon pass, July 9; D. 11508B, on other algae, Oneroa, near Pakakota, Aug. 5; MARSHALL ISLANDS—H. 48–1213.18, Amen I., Bikini Atoll, July 7, 1948. Plants of the last named collection had mostly 1–2 bare nodes between successive indeterminate branches.

A variant form of this species is represented by D. 11858.8 in which only a single, strictly terminal trichoblast occurs on the determinate branches. These specimens were collected by M. S. Doty and Jan Newhouse near Otetou, Raroia Atoll, Tuamotu Archipelago, July 21, 1952.

Herposiphonia dendroidea var. *minor* var. nov.

Figs. 7, 24

Epiphytic algae with the general features of the species, especially as regards trichoblasts, but much smaller, having determinate branches mostly 80–100 μ high and 25–35 μ in diameter, with 6–7 pericentral cells; determinate branches usually 3, between successive indeterminate

FIGS. 3-11. (Scale = 150 μ)

3. *Herposiphonia delicatula*, with procarps.
4. *Herposiphonia pacifica*. Tip of determinate branch, with spermatangial stichidia.
5. *Herposiphonia arcuata*. Apical portion of free part of indeterminate branch, with determinate and indeterminate branches.
6. *Herposiphonia parca* var. *interrupta*. Terminal portion of an indeterminate branch.
7. *Herposiphonia dendroidea* var. *minor*. Terminal portion of an indeterminate branch.
8. *Herposiphonia nuda*. Terminal portion of an indeterminate branch, with determinate branches.
9. *Herposiphonia dendroidea*, showing densely branched trichoblasts on the determinate branches.
10. *Herposiphonia filifera*. Terminal portion of a young determinate branch, with numerous short segments and immature trichoblasts.
11. *Herposiphonia subdisticha*, showing rudimentary trichoblasts at the apex of one or two determinate branches on the left.

branches, but frequently at alternate nodes, with indeterminate branches on the intervening nodes; trichoblasts mostly much shorter than in var. *dendroidea*; cystocarps terminal, prominently urceolate, 200 μ in diameter, 300 μ long; spermatangial branches unknown.

Algae epiphyticae proprietates speciei, praecipue trichoblastis, habentes, multo minores, autem, ramis determinatis plerumque 80–175 μ alt., 25–35 μ diam., cellulis pericentralibus 6–7; rami determinati plerumque in nodis alternatis orientes, ramis indeterminatis in nodis interjacentibus, aut interdum, tres rami determinati inter ramos indeterminatos successivos siti.

TYPE COLLECTION: D. 11533.2, tetrasporic, cystocarpic, on *Caulerpa* sp., under reef ledge, in front of Oneroa Village, Akau, Raroia Atoll, Tuamotu Archipelago, legit M. S. Doty and Jan Newhouse, Aug. 5, 1952. This collection is represented by a glucose slide mount and fluid-preserved material.

ADDITIONAL COLLECTIONS EXAMINED: TUAMOTU ARCHIPELAGO—all legit M. S. Doty and Jan Newhouse, 1952; D. 11368B1, D. 11477B, on *Microdictyon* sp., lagoon reef, Mataiva, Raroia Atoll, July 29; D. 11514, on *Liagora* sp., in channels, just north of Oneroa, Raroia Atoll, Aug. 5; D. 11538.1, on dead coral, and D. 11542B, on *Microdictyon* sp., along with the type collection; MARSHALL ISLANDS—H. 48–0914.6, outer reef, Uku I., Bikini Atoll, July 9, 1948; H. 48–1091A, on *Pocockiella* sp., outer reef, Arji I., Bikini Atoll, July 12, 1948; H. 48–1213.168, Amen I., Bikini Atoll, July 7, 1948; H. 48–1609A, on reef several miles north of Bikini I., Bikini Atoll, July 5, 1948; CAROLINE ISLANDS—all legit Ernani Meñez, 1960; D. 23032.3A, on *Microdictyon* sp., reef between Ifalik and Falalap islands (7° 14' N, 144° 27' E), Aug. 10; D. 23112.6, abundant on *Microdictyon* sp., reef, eastern side of Ifalik and Falalap islands, Aug. 10; D. 23207.2, abundant in algal turf on other algae, southern tip of Sorol I., Aug. 13; D. 23756.3, in algal turf on reef, Quoi I., Truk group, Aug. 2; MALDIVE ISLANDS—Ha. 30–2Q–17B, probably to be referred to this variety, was collected on Bushy I., Addu Atoll, May 10, 1964.

This variety is most commonly found growing on species of *Microdictyon*.

Herposiphonia dubia sp. nov.

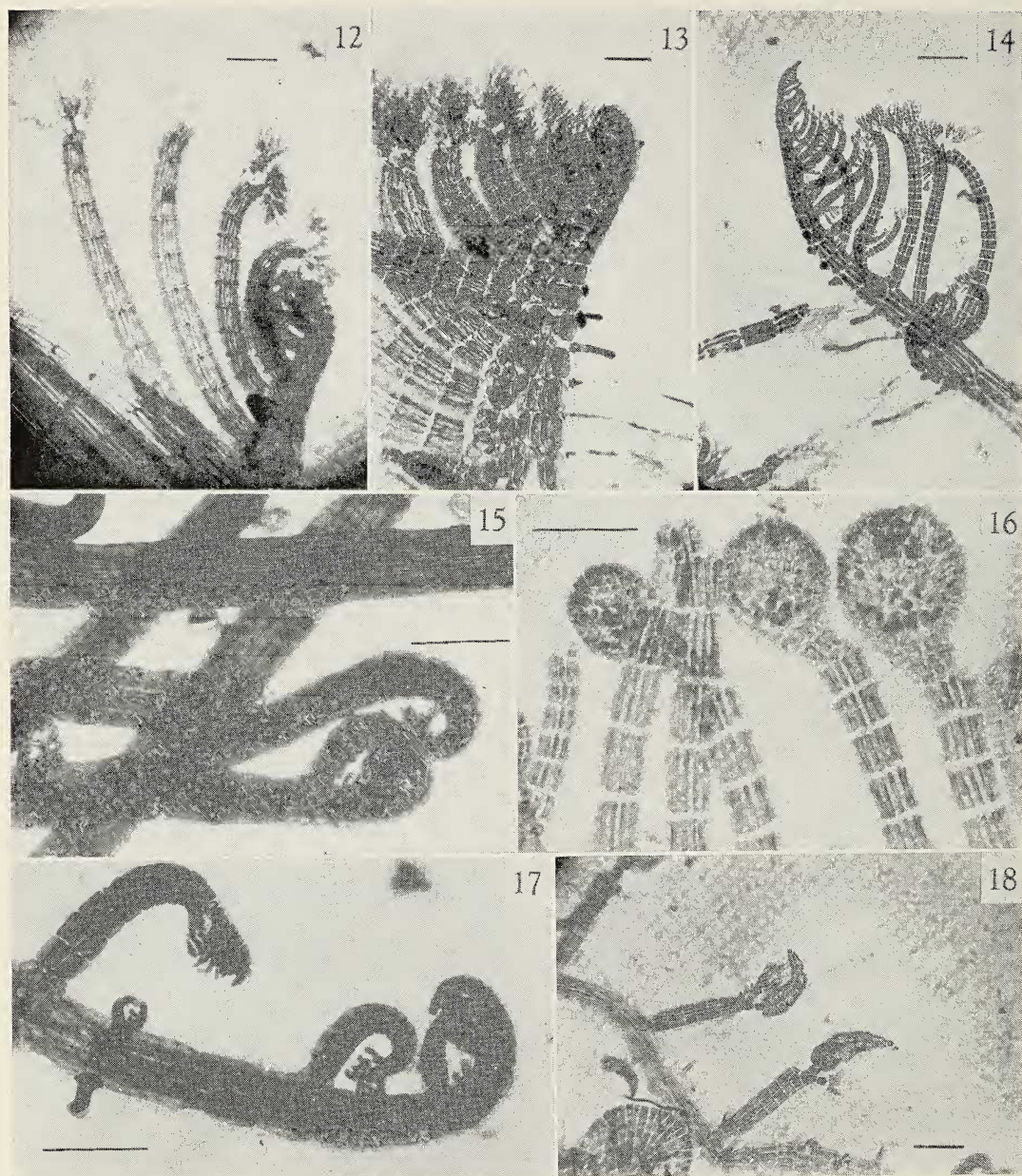
Fig. 15

Saxicolous algae forming extensive mats to 12 mm high; indeterminate prostrate branches to 150 μ in diameter, of segments 0.6–1.0 diameters long, with about 12 pericentral cells, and with 1–2 unicellular rhizoids per segment; apex of indeterminate branches and young determinate branches strongly inrolled; each determinate branch followed distally by an indeterminate branch and the latter followed by 1–2 bare nodes; determinate branches 100–120 μ in diameter, composed of 45–75 segments 1.0–1.5 diameters long, with 12–16 pericentral cells and a central cell distinctly larger to twice the diameter of the pericentral cells; apex of determinate branches blunt or rounded, often remaining inrolled or arched at or near maturity; secondary indeterminate branches frequently developing from the apical parts of determinate branches; walls relatively thick and brownish; chromatophores not zonate; trichoblasts mostly lacking but 1–2 very rudimentary ones occasionally present; tetrasporangia 40–50 μ in diameter in straight series of 15–25 in the upper parts of the determinate branches; sexual reproductive structures not observed.

Algae saxicolae, tegetes amplas usque ad 12 mm alt. formantes; rami indeterminati prostrati ad 150 μ diam., e segmentis 0.6–1.0 longioribus quam latis, c. 12 cellulas pericentrales atque 1–2 rhizoidea in omni segmento habentibus, compositi; 1–2 nodi nudi inter ramos indeterminatos successivos unum ramum distaliter consequentes; rami determinati 100–120 μ diam., e 45–75 segmentis 1.0–1.5 plo longioribus quam latis, 12–16 cellulas pericentrales habentibus, compositi; cellula centralis multo maior quam cellulae pericentrales; parietes crassiores; chromatophora non zonata; trichoblastae plerumque nullae, 1–2, autem, maxime rudimentariae interdum visae; tetrasporangia 40–50 μ diam., 15–25 in serie recta in partibus superioribus ramorum determinatorum; structurae reproductivae sexuales non observatae.

TYPE COLLECTION: D. 22472.1, tetrasporic, reef flat, Kahana, Maui, Hawaii, legit H., T., and B., Apr. 20, 1965. This collection is represented by several glucose slide mounts and fluid-preserved material.

ONE ADDITIONAL COLLECTION, D. 22349.1 was from rocks, mid-littoral, intertidal basalt east of Maalaea, Maui, legit H., T., and B., Apr. 19, 1965.



FIGS. 12-18. (Scale = 150 μ)

- 12, 13. *Herposiphonia crassa*. Terminal portion of an indeterminate branch.
 14. *Herposiphonia tenella*. Terminal portion of an indeterminate branch.
 15. *Herposiphonia dubia*. Terminal portion of an indeterminate branch and portions of determinate branches.
 16. *Herposiphonia parca*, showing immature terminal cystocarps.
 17. *Herposiphonia variabilis*. Terminal portion of an indeterminate branch.
 18. *Herposiphonia variabilis*, with terminal spermatangial stichidia.

In the branching pattern and the numerous segments in the determinate branches this species is similar to *H. pacifica*. From that species it differs in the relatively stiff determinate branches, with mostly shorter segments, but chiefly in the almost complete absence of trichoblasts. The tendency of the determinate branches to remain slightly arcuate at maturity and the bluntly rounded apices of the determinate branches are additional features distinguishing *H. dubia*.

Herposiphonia filifera sp. nov.

Figs. 2D, 10

Saxicolous algae with prostrate indeterminate branches 60–80 μ in diameter, composed of segments about 1 diameter long and attached by frequent unicellular rhizoids; determinate branches erect, unbranched, up to 6 mm high and 45–65 μ in diameter, with up to 57 segments, mostly 1.5–2.0 diameters long in median parts of mature branches; pericentral cells 12–14, central cells considerably larger, somewhat barrel-shaped, and with nearly as many chromatophores as the pericentral cells; 3 determinate branches in alternating positions between successive indeterminate branches, with no bare nodes; chromatophores frequently zonate; trichoblasts one per segment on the terminal 10–14 segments, alternately to pseudodichotomously branched 4–5 times, ultimately up to 500 μ long, arising in spiral sequence, with $\frac{1}{5}$ to $\frac{1}{6}$ divergence, somewhat tardily deciduous, leaving relatively small scar-cells on the branches, which are ultimately frayed at the attenuate apices; tetrasporangia 45–55 μ in diameter, tetrahedrally divided, in straight series of 15 or more toward the branch apices, not much distending the segments; cystocarps terminal, ovoid-globular, 240–373 μ in diameter; spermatangial stichidia in terminal, spiral series of 4 or more, wholly replacing trichoblasts, each lanceolate, and slightly to markedly arched toward the apex of the bearing branch, at maturity about 115 μ long and 16 μ in diameter at the base.

Algae tres ramos determinatos erectos inter ramos indeterminatos successivos habentes; rami determinati usque ad 6 mm alt., plerumque 45–65 μ diam., c. 12 cellulas pericentrales habentes, et e segmentis usque ad 57, 1.5–2.0 plo longioribus quam latis in partibus mediis, compositi; chromatophora vulgo zonata; trich-

oblastae in 10–14 segmentis terminalibus, plerumque una in omni segmento, sitae; pseudodichotome 4–5 ramosae, postremo usque ad 500 μ long., in spiram orientes, tarde deciduae; tetrasporangia 15 vel plura in serie versus apices ramorum, segmenta parum distendentia; cystocarpi terminales, ovoideo-globulares, ad 375 μ diam.; stichidia spermatangialia multa, pro trichoblastis omnino substituta, lanceolata, paululum arcuata, ad 115 μ long.

TYPE COLLECTION: T. 779.5, cystocarpic, in basalt tidepools, near Onenoa, Tutuila I., American Samoa, legit R. Buggeln, Aug. 13, 1964. Represented by a glucose slide mount and fluid-preserved material.

ADDITIONAL COLLECTIONS EXAMINED: AMERICAN SAMOA—T. 770B, tetrasporic, 772, spermatangial, on wave-dashed basalt shore, Ofu I., Manu'a group, legit R. Buggeln, Aug. 14, 1964; MALDIVE ISLANDS—Ha. 5–2B–119A–45B, tetrasporic, outer reef flat at a depth of 1 ft, south and southeast of Imma I., Male Atoll, Mar. 21, 1964; Ha. 30–2Q–19A, cystocarpic, at a depth of 3 ft, Bushy I., Addu Atoll, May 10, 1964; WESTERN ATLANTIC OCEAN—all previously identified as *H. tenella*; M. A. Howe 79 (N.Y.), tetrasporic, in littoral zone on *Rhizophora* roots near Hamilton, Bermuda Islands, June 22, 1900; M. A. Howe 4100 (N.Y.), in a tidepool, Georgetown, Great Exuma, Bahama Islands, Feb. 24, 1905; M. A. Howe 4151 (N.Y.), tetrasporic, on *Rhizophora* roots, Stocking I., Exuma Harbor, Bahama Islands, Feb. 21, 1905; a collection by William Randolph Taylor, no. 48, tetrasporic, on the walled side of a moat, Garden Key, Florida, 1924; a collection by W. R. Taylor and A. J. Bernatowicz, no. 25, Richardson's Cove, St. George I., Bermuda, Feb. 21, 1949; a collection by S. Bernard Lewis, no. A1073, Southwest Cay, Jamaica, June 1950.

All of the Atlantic specimens cited above seemed clearly referable to *H. filifera*, having the same branching pattern, approximately the same number of segments in the determinate branches, a similar number of pericentral cells and length of segments in mature determinate branches, a more or less simultaneous elongation of the segments of determinate branches, and numerous, relatively persistent trichoblasts of similar aspect, as well as other minor features.

Numerous tetrasporangia arise in series near the branch tips and the tips of older branches tend to become frayed.

H. filifera resembles *H. caespitosa*, described by Tseng (1944) from Hong Kong, in the branching pattern, in the numerous well developed, spirally disposed, branched trichoblasts, in the terminal cystocarps on shortened branches, and the numerous, terminal, spermatangial stichidia. From the description given by Tseng, *H. filifera* differs in being considerably more slender, in having nearly twice as many segments in the determinate branches, in the tapering rather than "obtuse-rounded" apices of the determinate branches, in tetrasporangia more numerous and more terminal in position, and in considerably smaller and arcuate spermatangial stichidia without the large sterile terminal cell described for *H. caespitosa*. Efforts to obtain specimens of *H. caespitosa* for comparison have been unsuccessful.

In the number of pericentral cells and the number of segments in the erect branches, as well as in the numerous tetrasporangia in the upper parts of the determinate branches, *H. filifera* resembles *H. pacifica*. It differs from *H. pacifica* in the lack of bare nodes on the indeterminate branches, in the more or less simultaneous elongation of the numerous segments of young determinate branches, and in the relatively persistent trichoblasts, which likewise develop more or less simultaneously, 8 or more being commonly present at one time, rather than mostly 1-2 being present at a given time as in *H. pacifica*. Furthermore, scar-cells are relatively small in *H. filifera*, but large in *H. pacifica*.

Herposiphonia nuda sp. nov.

Figs. 2E, 2F, 2I, 8

Epiphytic algae, with prostrate, indeterminate axes attached to the host by frequent unicellular rhizoids, with a branch on every node, and with 3 erect determinate branches in alternate positions on either flank between successive indeterminate branches, as is characteristic of the genus in general; prostrate branches 80-105 μ in diameter, with mostly 7-8 pericentral cells and slightly smaller central cells, and with segments 1-2 diameters long; determinate branches very slender, 2-3-(3.5) mm high, 40-60(80) μ in diameter, composed of 25-30-(44) segments

1.5-3.5 diameters long, with 4-5 pericentral cells slightly flattened periclinally and a much more slender central cell, the branches terminating in a conical or rounded cell, and occasionally bearing a lateral branch; chromatophores seemingly not zonate; trichoblasts and scar-cells totally lacking in vegetative branches; spermatangial stichidia 2-3 per ramulus, arising from the entire trichoblast primordium on the concave side of the young branches well above the median point, lanceolate, about 275 μ long and 70 μ in diameter at maturity and bearing a sterile tip of 2-3 cells; procarys arising in similar positions; mature cystocarps and tetrasporangia not observed.

Algae epiphyticae, rami prostrati tres ramos determinatos erectos inter ramos indeterminatos successivos ferentes; rami prostrati 80-105 μ diam., cellulis pericentralibus plerumque 7-8; rami determinati 2-3-(3.5) mm alt., 40-60-(80) μ diam., e 25-30-(44) segmentis 1.5-3.5 plo longioribus quam latis compositi, cellulae pericentrales segmentorum 4-5, cellula centrali multo tenuiore; rami in cellulam conicam rotundatamve desinentes, ramum lateralem interdum ferentes; chromatophora non zonata; trichoblastae et cellulae-cicatrices in ramis vegetativis nullae; stichidia spermatangialia 2-3 in omni ramulo, e primordio trichoblastae toto in latere concavo ramorum iuvenum longe supra partem mediam orientia, lanceolata, matura c. 275 \times 70 μ , cacumen sterile e 2-3 cellulis constans ferentia; procarys similiter positi; cystocarpium maturi atque tetrasporangia non observata.

TYPE COLLECTION: D. 19137J1, cystocarpic and spermatangial, on *Padina* sp., dredged at 15-20 fa, Ilio Point, Molokai, Hawaii, Sept. 7, 1959. This collection is represented by one glucose slide mount and fluid-preserved material.

ADDITIONAL COLLECTIONS EXAMINED: HAWAIIAN ISLANDS—D. 19135J1, spermatangial, D. 19135K2, cystocarpic, and D. 19135Z2, on *Hypnea* sp., all epiphytic and dredged at 26 fa, in front of the river mouth, Waialua, Oahu, Aug. 2, 1959; D. 19137N1, sterile, dredged along with the type; MARSHALL ISLANDS—G. 760.3, on *Halimeda* sp. in the lagoon at a depth of 9 m, Eniwetok Atoll, Sept. 7, 1955; MALDIVE ISLANDS—Ha. 15-1F-124-26, on a foliose red alga, dredged at 36 fa, in the lagoon near Bomasdu I., Miladummadula Atoll, Mar. 29, 1964; Ha. 26-2N-23A, at a depth of 2 ft, Wilingili, Addu Atoll, Apr. 30, 1964.

This species is similar to *H. tenella* in its slender form and pattern of branching. It differs from that species in having fewer pericentral cells and considerably longer and more slender segments in the determinate branches, but more especially in the lack of trichoblasts and in the point of origin of sexual reproductive structures.

Herposiphonia obscura sp. nov.

Fig. 25

Epiphytic algae with prostrate indeterminate branches about 100 μ in diameter, with 8–10 pericentral cells and composed of segments mostly about 1 diameter long, attached by frequent unicellular rhizoids arising singly at the nodes; apex of indeterminate branches only moderately inrolled; erect determinate branches with 8–10 pericentral cells and composed of mostly 7–20 segments, very variable in number in determinate branches on a given indeterminate branch, rarely by renewed apical growth with up to 85 segments; segments in determinate branches 0.5–1.5 diameters long, with a diameter similar to that of the indeterminate branches; each determinate branch followed distally by an indeterminate branch and 1–3–(5) bare nodes; indeterminate branch primordia mostly remaining very rudimentary, consisting of about 5 or 6 cells representing the first very short segment of the branch; chromatophores not zonate; walls thin, usually brownish, dissepiments opaque; trichoblasts 1–2, terminal, mostly absent or very rudimentary, rarely up to 300 μ long, with 3–4 dichotomies; reproduction unknown.

Algae epiphyticae, ramos prostratos indeterminatos c. 100 μ diam., cellulis pericentralibus 8–10, apice modicius involuto, habentes; rami erecti determinati similes, cellulas pericentrales 10–12 habentes, et e 7–18–(40) segmentis 80–90 μ diam., 0.5–1.5 plo longioribus quam latis compositi; ramus indeterminatus aut primordium rami et unus ad tres nodi nudi omnen ramum determinatum distaliter consequentes; primordia ramorum indeterminatorum maxima ex parte semper magnopere elementaria, e c. 5–6 cellulis, segmentum primum rami brevissimum experimentibus, constantia; chromatophora non zonata, membranis tenuibus, subbruneis, dissepimentis opacis; trichoblastae nullae aut raras elementaresque, reproductio ignota.

TYPE COLLECTION: D. 19645J1, epiphytic, dredged off Ewa Beach, Oahu, Hawaii, Feb. 22, 1962. This collection is represented by a

glucose slide mount and fluid-preserved material.

ADDITIONAL COLLECTIONS EXAMINED: HAWAIIAN ISLANDS—D. 19117B1, epiphytic, dredged at 25 fa, Pokai Bay, Oahu, July 30, 1959; D. 19136K2, epiphytic, dredged at 16 fa, Waialua, Oahu, Aug. 2, 1959; D. 19645A1, D. 19645L2, dredged off Ewa Beach, Oahu, along with the type collection; LINE ISLANDS—D. 18995.1, on *Halimeda* sp., seaward reef flats, Christmas I., (1° 55' N, 157° 20' W), May 16, 1962; D. 20022.1, on *Halimeda* sp., June 3, D. 20040, on coral, seaward reef flats, Christmas I., May 16, 1962 (all of the Christmas Island collections were made by Ralph F. Palumbo); GILBERT ISLANDS—D. 18937.5, epiphytic, coral reef, Marakai I., legit Jane Cooper, July, 1962, identified by R. Tsuda (1964) as *Polysiphonia fragilis* Suringar; MALDIVE ISLANDS—Ha. 11–1D–122B–16, dredged at 25–35 fa, near Maduvari I., southwest boundary of Fadifolu Atoll, Mar. 25, 1964.

A collection by Leonard Horwitz, no. 9598a, from the lagoon side of Ine I., Arno Atoll, June–Aug. 1951, identified by E. Y. Dawson (1956:59) as *Lophosiphonia bermudensis* Collins and Hervey, is certainly a *Herposiphonia* and probably *H. obscura*, judging by Dawson's Fig. 65, in which the determinate branches are followed by the very rudimentary indeterminate branch primordia and then two bare nodes. The rhizoids arise from the morphologically distal end of the pericentral cells as seen by the relative positions of determinate and indeterminate branches.

Due apparently to the thinness of the walls, plasmolysis of the cells of this species readily occurs in the dilute glucose mounting medium used. The central cells in this species are about the same diameter as the pericentral cells. The very rudimentary indeterminate branches constitute perhaps the most distinctive feature of this species.

Herposiphonia pacifica sp. nov.

Figs. 2A, 2B, 4, 19

Chiefly saxicolous algae, forming extensive turf or tufts up to 1.5 cm high; prostrate branches 100–170–(200) μ in diameter, with

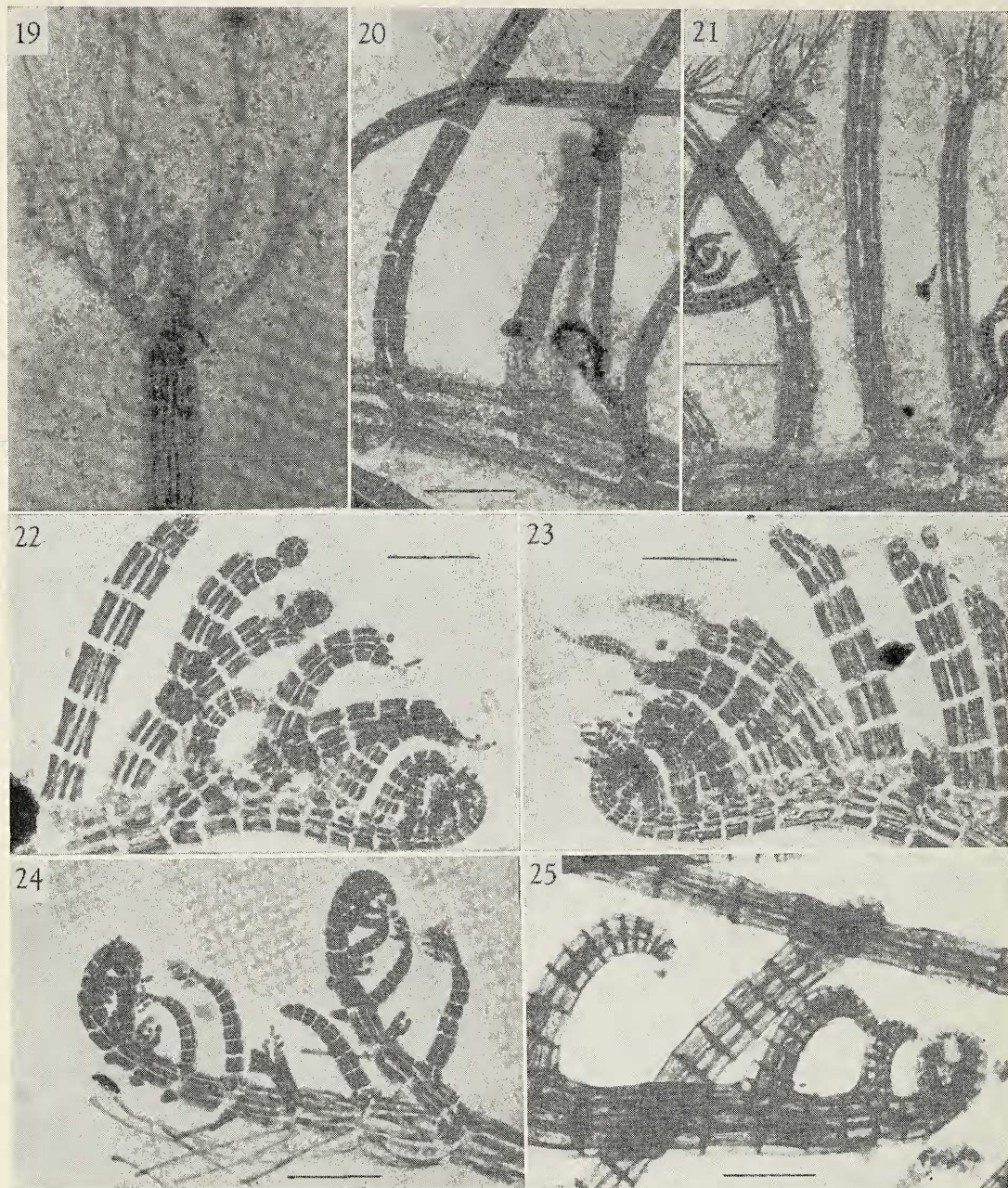


FIG. 19-25. (Scale = 150 μ)

19. *Herposiphonia pacifica*. Apex of determinate branch.
20. *Herposiphonia parca* form *dispar*, showing the comparative size of determinate and indeterminate branches.
21. *Herposiphonia variabilis*, showing a variant branching pattern.
22. *Herposiphonia parca*, with young terminal cystocarps.
23. *Herposiphonia parca*, with young terminal spermatangial stichidia.
24. *Herposiphonia dendroides* var. *minor*. Terminal portion of indeterminate branch.
25. *Herposiphonia obscura*. Terminal portion of an indeterminate branch and parts of mature determinate branches.

8–10–(12) pericentral cells and composed of segments about 1 diameter long, attached by unicellular rhizoids arising at irregular intervals, mostly one per segment and having mostly digitate tips; indeterminate branches arising on alternate sides of prostrate axes at intervals of 3–5 segments, with a single determinate branch between successive indeterminate branches, and with the latter always one node distal to the former; determinate branches normally simple, 60–90–(140) μ in diameter, composed of (30)–60–80–(100) segments, which are mostly about 1.5 diameters long in median parts, and which have mostly 12–14 pericentral cells, but may have as few as 8 or as many as 16; central cell at least twice as wide as the pericentral cells; determinate branches usually gradually narrowed at the base and gradually or abruptly narrowed at the apex; chromatophores usually not zonate; trichoblasts 3–5–(8), up to 2 mm long, with about 7 forks, arising somewhat distichously, at decreasing intervals of 8 segments to 1 segment, mostly 1–2 being present at one time; scar-cells relatively large; tetrasporangia in long series of 20–30 in the terminal parts of the branches, slightly distending the segments; spermatangial stichidia lanceolate-arcuate, 400–560 μ long, 50–80 μ broad at the base; with a sterile tip of 1–2 short cells, up to 6 or more stichidia arising in acropetal succession at intervals of 6–1 segments at the apices of the branches; procarps and cystocarps not observed.

Algae praesertim saxicolae, caespitem penicillosoe amplis usque ad 1.5 cm alt. formantes; rami prostrati 100–170–(200) μ diam., cellulasa pericentrales plerumque c. 10 habentes, et e segmentis circa aequae longis ac latis compositi; rami indeterminati in latibus alternis ramorum prostratorum, intervallis 3–4–(5) segmentis, orientes, unico ramo determinato inter ramos indeterminatos successivos sito, ramo determinato in nodo qui distaliter ramum indeterminatum admodum praecedat semper sito; rami determinati normaliter simplices, 60–90–(140) μ diam., e 60–80–(100) segmentis compositi, segmentis c. 1.5 plo longioribus quam latis, et plerumque 12–14 cellulasa pericentrales diametro c. dimidia pars cellulasa centralis habentibus; chromatophora non zonata; trichoblastae 3–5–(8), usque ad 2 mm long., 7–(9) furcas habentes, et intervallis decrescentibus 8 ad 1 segmenta, saepissime 1–3 semel subdistiche orientes; cellulasaecitricae magnae; tetrasporangia in partibus terminalibus ramorum determinantum 20–30 seriatim disposita, segmenta paululum distentia; stichidia spermatangialia lanceolato-arcuata, 400–560 \times 50–80 μ , cacumen sterile ex

1–2 cellulasa brevibus constans habentia; usque ad 6 stichidia in successione acropetali, intervallis 6–1 segmentis ad apices ramorum determinantum, orientia; cystocarpi ignoti.

TYPE COLLECTION: D. 22396, tetrasporic, on basalt shore, intertidal, near Maalaea, Maui, legit H., T., and B., April 19, 1965. This collection is represented by a glucose slide mount and fluid-preserved material.

ADDITIONAL COLLECTIONS EXAMINED: HAWAIIAN ISLANDS—T. 934A, coral reef, Trig I., French Frigate Shoal, legit C. R. Long, Sept. 27, 1964; T. 581, beach drift, northeast side of Laysan I., Dec. 7, 1963; D. 12699.1, in intertidal reef pockets, Hanauma Bay, Oahu, Jan. 15, 1962; H. 66–6, basalt ledge, northwest shelf, Hanauma Bay, Oahu, Sept. 16, 1966; collections by G. F. Papenfuss, Hanauma Bay, Oahu, Dec. 15, 1940, and Mar. 1, 1942; a collection by Gary Collins, no. 121, Wawamalu Beach, Oahu, Feb. 28, 1965; D. 22409.1, in algal turf, north of Papawai Point, Maui, legit H., T., and B., Apr. 19, 1965; D. 22503, Pene Beach Park, Honolulu, Maui, legit H., T., and B., Apr. 20, 1965; D. 13458.1, on basalt ledge, west lip of Pohoiki Bay, island of Hawaii, Nov. 10, 1956; JOHNSTON ISLAND—T. 1234, on dead coral, legit Earl Murchison, Aug. 20, 1965; LINE ISLANDS—L. 2708.2, tetrasporic, turf on rocks near breakers, southwest reef, Jarvis I., Nov. 16, 1964; TUAMOTU ARCHIPELAGO—D. 11215.1, D. 11217B,C, on coral and on wood stump at a depth of about 5 ft, near the lagoon transect, Ngarumaoa, Raroia Atoll, legit M. S. Doty and Jan Newhouse, July 16, 1952; PHOENIX ISLANDS—L. 2534.5, west side of lagoon, Gardiner I., Oct. 23, 1964; AMERICAN SAMOA—T. 752, on wave-washed basalt, Vatia Bay, Tutuila, legit R. Buggeln, Aug. 1964; GILBERT ISLANDS—D. 18900 (*Lophosiphonia obscura* of Tsuda, 1964), in shallow passage between the ocean and the lagoon, Abemama I., legit M. J. Cooper, July 1962; MARSHALL ISLANDS—G. 612.1, tetrasporic, and G. 613, at a depth of 19 m, lagoon, Eniwetok Atoll, Sept. 6, 1955; H. 48–0290.1, on *Dictyosphaeria* sp., and *Eucheuma* sp., inner reef, Eric I., Bikini Atoll, July 13, 1948; H. 48–0914.1, tetrasporic, on *Eucheuma* sp., H. 48–0914.21, on *Pocockiella* sp., and H.

48-0914.17, Uku I., Bikini Atoll, July 13, 1948; H. 48-Y58.4, Bijiiri I., Eniwetok Atoll, July 26, 1948; GILBERT ISLANDS—D. 18900, lagoon entrance, eastern side of Abemmama I., legit M. J. Cooper, July, 1962; CAROLINE ISLANDS—all legit Ernani Meñez, 1960; D. 15586.5, on *Pardina* sp., reef at Koror I., Palau Group, Sept. 15; D. 21709.6, D. 21710.5, on dead coral, D. 15676.1, on other algae, reef flat, Epelkapw I., Ponape, June 20; D. 15721.1, 21739.1, on dead coral, on reef eastern side of Mantapeitak I., June 20; D. 21079.3, on other algae, Helen Reef, western Caroline Islands, Aug. 28; D. 23112.2A, on *Microdictyon* sp., reef on the eastern side of Ifalik and Falalap Islands, Aug. 10; D. 23207.3, among other algae, southern tip of Sorol I., Aug. 13; PHILIPPINE ISLANDS—D. 18210B, among other algae, Mawes I., Hinatuan, Surigao, July 7, 1958; VIET NAM—E. Y. Dawson no. 11247, spermatangial, on coral, in a lagoon, Hòn Miêü, Nhatrang, Feb. 3, 1953; MALDIVE ISLANDS—Ha. 5-2B-119C-28A, Ha. 5-2B-119A-52A, Ha. 5-2B-119A-53D, island lagoon at a depth of 1-2 ft, outer reef flat, southeast and south of Himmafari I., Male Atoll, Mar. 21, 1964; Ha. 9-2E-121-33A, on *Caulerpa* sp., along channel sides between Maro and Mafilefuri, Fadiffolu Atoll, Mar. 24, 1964; Ha. 20-2J-129-6, Ha. 20-2J-129-7, on a reef at a depth of 3-10 ft, Ugufaru, North Malosmadula Atoll, Apr. 21, 1964; Ha. 29-2P-11, Ha. 29-2P-12, spermatangial and Ha. 29-2P-13, in *Thalassia* beds, on a small island south of Fedu I., Addu Atoll, May 8, 1964.

Indeterminate branches were observed in several instances to develop from the upper parts of determinate branches in the case of L. 2708.2 listed above. On account of the reduced number of pericentral cells in the plants of this collection there is some question concerning their identity.

This widely distributed and fairly common species exhibits considerable variability in size. Specimens collected in more isolated areas such as Johnston Island and the Marshall Islands are usually smaller than those on larger land masses such as the Hawaiian Islands and the Asiatic mainland. However, more slender forms occur also in the Hawaiian Islands. One such collection, D. 17197A2, has determinate branches

mostly less than 100 μ in diameter, with segments mostly not over 1 diameter long. It was collected from Kalapana Beach, Kaimu Bay, island of Hawaii, Feb. 27, 1953. Of special interest in this collection is the occurrence of a mature cystocarp attached at about the 8th segment from the base of the determinate branch. The cystocarp is distinctly urceolate and is about 300 μ in diameter. In view of the terminal position of the spermatangial stichidia of *H. pacifica*, the position of this cystocarp would seem to make questionable the identity of this collection.

Herposiphonia parca Setchell. Setchell 1926:103
H. terminalis Segi 1954:365, nomen nudum
 Figs. 2C, 16, 20, 22, 23

Epiphytic algae, with prostrate indeterminate branches typically 100-130 μ in diameter, composed of segments 1.0-1.5-(2.0) diameters long, with 8-10 pericentral cells and attached by numerous rhizoids, often with digitate or multicellular apices; 3 determinate erect branches in regular sequence between successive indeterminate branches, typically without bare nodes; determinate branches strongly arched when young, composed of 8-12-(20) segments, mostly about 1 diameter long but often shorter or up to 2.5 diameters long, (40)-50-75-(90) μ in diameter, with mostly 8-10 pericentral cells; chromatophores often zonate; trichoblasts 2-(3), terminal, the shorter one on the side toward the apex of the bearing branch; trichoblasts with 3-5 unequal forks and tapering to delicate tips, often rudimentary but frequently to 400 μ long and occasionally up to 1.2 mm long; tetrasporangia in straight series of mostly 5-6 in the middle or lower segments of determinate branches; procarps and cystocarps strictly terminal, the cystocarps globular to slightly urceolate, up to 400 μ in diameter; spermatangial stichidia 2-(3), terminal, oblong at maturity, up to 190 \times 80 μ with a sterile tip of 1-2-(5) cells.

TYPE LOCALITY: Tahiti. This is one of the most common species found in the central tropical Pacific Ocean. Examination of the type collection, represented by four slide mounts, kindly loaned by the University of California at Berkeley, confirmed the writer's opinion that the

numerous collections listed herewith are readily referable to *H. parca*, although more segments commonly occur in the determinate branches than are present in the type material.

Considerable variability occurs among the various collections. Frequently encountered are more slender forms with up to 20 segments in the determinate branches and with the segments 2 or more diameters long. These variants are indicated in the following account with an asterisk. In some of these there are only 6 pericentral cells in the segments of the determinate branches. Another variant has indeterminate branches up to 3 times the diameter of the determinate branches. These are marked with a dagger (†) and are designated as form *dispar*.

COLLECTIONS EXAMINED: HAWAIIAN ISLANDS—D. 19144L4*†, dredged 6–12 fa, Port Allen, Kauai, Sept. 12, 1959; a collection by Gary Collins, tetrasporic, on *Galaxaura* sp., Haena Beach, Kauai, Apr. 16, 1965; D. 8904*†, 8905.1*†, in connecting channel of holding ponds, Coconut I., Kaneohe Bay, Oahu, Oct. 13, 1951; D. 10821A*†, on a boat just below the water line, Kaneohe Bay, Oahu, Oct. 7, 1953; D. 19135AA1*†, D. 19136F1†, dredged at 15 fa, in front of river mouth, Waialua, Oahu, Aug. 2, 1959; D. 19706.1, awash at Kailua Beach, Oahu, Sept. 20, 1962; D. 20047.1, on rocks, Laie, Oahu, legit R. Tsuda, G. Trono, and R. Buggeln, May 5, 1963; H. 65–65, spermatangial, on *Codium* sp., bottom of large tide pool, Wawamalu Beach, Oahu, May 1, 1965; a collection by Gary Collins, tetrasporic, dredged at 2–3 fa, Kaneohe Bay, Oahu, Mar. 20, 1965; D. 22301.2, in a tidepool, northeast bench, Hanauma Bay, Oahu, legit R. Tsuda, Feb. 17, 1965; D. 19137A1*, spermatangial, dredged at 15–20 fa, Ilio Point, Molokai, Sept. 7, 1959; D. 22384, D. 22389, D. 22390.1, on other algae, basalt shore, near Maalaea, Maui, legit H., T., and B., Apr. 19, 1965; D. 17063.1, on *Amansia*, on wave-dashed basalt, Pohoiki, Puna, island of Hawaii, Jan. 27, 1953; D. 20193.5, in algal turf, Kaena ponds, Kaena, Puna, island of Hawaii, Mar. 19, 1965; a collection by John Fitzsimons, on other algae, Kapoho, island of Hawaii, Mar. 1, 1965; JOHNSTON ISLAND—H. 65–118*, tetrasporic, H. 65–136, tetrasporic, spermatangial, on dead coral at a depth of 1–2

m, 20 m shoreward from the outer reef margin, north of North Island, legit R. S. Jones, Apr. 22, 1965; LINE ISLANDS—L. 2703.6*, on *Laurencia* sp., on exposed coral heads, Jarvis I., Nov. 16, 1964; SOCIETY ISLANDS—D. 12095.1, D. 12099.1, on other algae, under coral boulder, lagoon shore, Arue Pt., Tahiti, Sept. 15, 1952; FIJI ISLANDS—D. 12123.1*, in algal turf, Navuevu Cuvu, Singtaka, Viti Levu, Sept. 22, 1952; GILBERT ISLANDS—D. 18904.1*†, tetrasporic, Abemmama I., legit M. J. Cooper, July, 1962; MARSHALL ISLANDS—D. 12723.1, on other algae, seaward reef, Parry I., Eniwetok Atoll, July 24, 1954; G. 749.1, at a depth of 9 m, lagoon reef, Eniwetok Atoll, Sept. 7, 1955; H. 48–Y58.21, on other algae, Runit I., Eniwetok Atoll, July 27, 1948; CAROLINE ISLANDS—all legit Ernani Meñez, 1960; D. 21838.2, on other algae, reef flat at Epwelkapw, Ponape (6°59'N, 158°11'E), June 16; D. 15071.1, on *Amphiroa* sp., on reef, eastern side of Mantapeitak I. (7°15'N, 158°18'E), June 20; D. 21046†, tetrasporic, on sea grass, south end of Moen I., Truk group, Aug. 1; D. 23656.2, on *Padina* sp., reef at Falas I., Truk group (7°32'N, 151°45'E), D. 23804.1, on branching coralline, Falas I., D. 23811, on branching coralline, Falas I., all July 30; D. 23648.1, on dead coral, Dublon I., Truk group, July 31; D. 23253.2, on dead coral, southern tip of Sorol I. (8°8'N, 140°4'E), Aug. 13; D. 23359.1, D. 23471.3, D. 21857.3*, on other algae, reef at Yap I. (9°29'N, 138°8'E), Aug. 13; D. 15586.2*, tetrasporic, D. 15556.2, spermatangial, on *Sargassum* sp., on reef, Koror I., Palau group, Sept. 5; D. 15981.1*, tetrasporic, on *Padina* sp., on reef at Iwayama Bay, Palao I. (7°20'N, 134°31'E), Aug. 22; D. 15576.2, on *Padina* sp., D. 15654.1, tetrasporic, on other algae, D. 21721, on other algae, all from reef flat, Pulo Anna I., Sept. 3; D. 15398A1, on *Turbinaria*, south end of Helen Reef (2°48'N, 131°45'E), Aug. 28; PHILIPPINE ISLANDS—D. 18103B, 18103C, on other algae at a depth of 3–6 ft, near Davao, Mindanao, June 22, 1958; three collections by D. P. Abbott, 1957, a tetrasporic specimen from sand flats east of Laminusa I., Siasi, Sulu Sea, Jan. 29, sterile specimens on a reef flat west of Cagayan, Sulu Sea, Feb. 28, and spermatangial and cystocarpic specimens from Gnat Reef, Balabac I., Mar. 4; GUAM—D. 20135, D. 20136, on

corallines, legit Ernani Meñez, June 10–12, 1960; INDONESIA—a collection by A. Weber-van Bosse (as *Herposiphonia tenella*), on *Gelidiella* sp., from Maumeri I., Flores, kindly loaned from the Rijksherbarium, Leiden; an unnumbered collection, slender form, on a sea grass, Tandjung Gul, Singapore, Jan. 1965; MALDIVE ISLANDS—Ha. 5–2B–119C–54E, F, Ha. 52B–119C–63A, southeast and south of Himmafari I., Male Atoll, Mar. 17, 1964; Ha. 19–2I–1, tetrasporic, on reef at a depth of 3 ft, Dinidu Faro, Male Atoll, Apr. 19, 1964; Ha. 24–21–132–16 and 17, on *Amphiroa* sp., reef flat at a depth of 4 ft, Walla Faru, South Nilandu Atoll, Apr. 24, 1964; Ha. 29–2P–12, spermatangial, in *Tbalassia* beds on a small island south of Fadu I., Addu Atoll, May 8, 1964; David Sigee no. 78, Gan I., July–Sept. 1964.

A collection by E. Y. Dawson, no. 7360C, cystocarpic, Summerland Keys, Florida, May 28, 1949, seems readily referable to *H. parca*. These specimens bear several strictly terminal cystocarps, which are strongly urceolate at maturity, measuring 480 μ in diameter and 640 μ in length.

Herposiphonia parca var. *interrupta* var. nov.
Fig. 6

With the features of the species but with a bare node generally occurring between the first and second determinate branches in a distal direction from a given indeterminate branch.

Algae proprietates speciei praebentes, plerumque, autem, nodum nudum inter ramos determinatos primos secundosque habentes, a ramo indeterminato distaliter positum.

TYPE COLLECTION: D. 22369, tetrasporic, in algal turf and on *Gracilaria*, Maalaea Jetty, Maui, legit H., T., and B., Apr. 19, 1965. The type collection is represented by a glucose slide mount and fluid-preserved material. This variety is known only from collections in the Hawaiian Islands, where it is common. Mature reproductive structures were not observed.

COLLECTIONS EXAMINED: D. 10074.1, in front of stream mouth, Moloaa Bay, Kauai, legit Jack Randall, Feb. 2, 1952; D. 10281, reef flat, Hanalei Bay, Kauai, legit Jack Randall, Feb. 7, 1952; D. 8066, D. 8077, D. 8083, Kawela, Oahu, Oct. 16–17, 1950; D. 8215.1, Mokuleia,

Oahu, Oct. 15, 1950; D. 8428, D. 8509.1, D. 8519.1, on other algae, Sand Island, north end of Kaneohe Bay, Oahu, Nov. 24, 1950; D. 8837.1, on other algae, midtide level, Manana I., Oahu, Apr. 22, 1951; D. 9742.1, on *Laurencia* sp., near Sans Souci Beach Laboratory, Waikiki, Oahu, Jan. 13, 1952; D. 9947.1, with immature cystocarp and spermatangial stichidia, near Sans Souci Beach Laboratory, Waikiki, Oahu, Mar. 21, 1952; D. 9982.1, D. 9983.1, on rock shelf, in front of Marine Laboratory, Kaneohe Bay, Oahu, Mar. 28, 1952; D. 10583.1, on *Jania* sp., Sans Souci Beach Laboratory, Waikiki, Oahu, Mar. 14, 1953; D. 12236, Mokuleia, Oahu, Nov. 9, 1952; D. 12438.1, on *Gelidium* sp., in front of Ala Moana Park, Honolulu, Apr. 12, 1954; D. 12746.1, on *Champia* sp., Laie, Oahu, Jan. 16, 1955; D. 13014.1, Koloa, Oahu, Oct. 30, 1955; D. 19305.1, on *Hypnea* sp., awash, Sans Souci Beach Laboratory, Waikiki, Oahu, Mar. 7, 1960; H. 65–7, on *Microdictyon* sp., Makaha Pt., Oahu, Feb. 28, 1965; an unnumbered collection by Gavino Trono, near the outer reef margin, on other algae, Kaaawa, Oahu, Nov. 28, 1964; D. 19137J2, on *Padina* sp., dredged 15–20 fathoms off Ilio Pt., Molokai, Sept. 7, 1959; D. 22409.2, in algal turf, near McGregor Pt., Maui, legit H., T., and B., Apr. 19, 1965; D. 22411, on *Laurencia* sp., near McGregor Pt., same date and collectors; D. 22484, on other algae, basalt reef flat north of Kahana, Maui, legit H., T., and B., Apr. 20, 1965; D. 13442.2, with *Champia* sp., on basalt ledge, west lip of Pohoiki Bay, island of Hawaii, Nov. 10, 1956.

Herposiphonia subdisticha Okamura. Okamura (1899:11)

Fig. 11

Decumbent algae 2 cm or more long, attached by frequent unicellular rhizoids, with distichous or nearly distichous branches, with a determinate or an indeterminate branch on every node and with 3 alternating determinate branches between 2 successive alternating indeterminate branches; determinate branches 500–600 μ long, 70–100 μ in diameter, with mostly blunt apices and narrowed at the base, slightly to strongly curved toward the tip of the bearing branch, and often slightly curved toward the substratum, composed of 10–12 segments mostly shorter than broad,

pericentral cells 10–12, around a central cell at least twice as broad, the pericentral cells somewhat obliquely oriented; trichoblasts terminal, infrequent, mostly very rudimentary, with 1–3 forks, occasionally as much as 1 mm long, soon deciduous; tetrasporangia about 65μ in diameter, in straight series of 3–4 or more in swollen segments of determinate branches borne on short indeterminate laterals, not in the determinate branches of main axes; sexual plants not observed.

TYPE LOCALITY: Enoshima, Boshu, Japan.

A single collection, D. 12122T, tetrasporic, abundant on a branching coralline alga, was taken at Navuevu Cuvu, Singtoka, Viti Levu, Fiji Islands, Sept. 22, 1952. The specimens conform in general to Okamura's description, including the presence of the usually very rudimentary trichoblasts. From Okamura's description the Fijian specimens differ in several respects: (1) they are probably more strictly distichous, with the determinate branches curving slightly toward the substratum; (2) the apices of indeterminate branches are slightly inrolled; (3) the tetrasporangia seem to be borne in the determinate branches of short lateral indeterminate branches, a feature not reported for *H. subdisticha*. Information concerning the sexual reproductive structures may be necessary to determine whether or not the Fijian alga is to be identified with the Japanese species.

Dawson (1963:434) concluded that *H. rigida* Gardner (1927:100), *H. rigida* var. *laxa* Setchell and Gardner (1930:164), and *H. parva* Hollenberg (1943:575) (*H. pygmaea* Hollenberg, in Smith 1944:369) are all to be identified with *H. subdisticha*. Apparently Dawson failed to note that Okamura described the determinate branches of *H. subdisticha* as bearing "in its young state very short and minute deciduous fibrillae at the apex." Examination of many specimens of distichous *Herposiphonia* from the coast of California has failed to reveal a single instance of trichoblasts on the determinate branches. Furthermore, the California specimens are strictly distichous rather than subdistichous, and the determinate branches are not narrowed at the base as in the case of the Fijian specimens. The position of the sexual reproductive structures, when known, may provide further distinc-

tions. Cystocarps of distichous specimens of *Herposiphonia* from California are borne toward the base of the determinate branches.

It seems necessary to conclude that distichous *Herposiphonia* plants from California should not be referred to *H. subdisticha*.

Herposiphonia tenella (C. Ag.) Schmitz 1889: 449

Hutchinsia tenella C. Agardh 1828:105

Fig. 14

Epiphytic algae, with prostrate indeterminate branches 80–90 μ in diameter, with about 8 pericentral cells, and composed of segments mostly 1.0–1.5 diameters long, bearing 3 erect determinate branches in alternating positions between successive indeterminate branches, with mostly no bare nodes; determinate branches up to 1.5 mm high, 50–60 μ in diameter, composed of 16–18 segments, mostly about 1.5 diameters long, with 8–9 pericentral cells; chromatophores zonate; trichoblasts 2–5, in spiral sequence on the branches, the first one arising 2–8 segments from the ultimate apex, with 3–4 forks, mostly short, but occasionally up to 1.5 mm long; spermatangial stichidia (only one observed) 190 μ long, 35 μ broad, cylindrical, with a one-celled short sterile tip, borne on the third segment from the branch apex; procarps, cystocarps, and tetrasporangia not observed.

TYPE LOCALITY: On the coast of Sicily.

COLLECTIONS STUDIED: HAWAIIAN ISLANDS—H. 65–33, H. 65–108.1, on other algae, dredged at 2–5 fathoms, Kaneohe Bay, Oahu, Mar. 20, 1965; PHILIPPINE ISLANDS—an unnumbered collection by D. P. Abbott, on other algae, Gnat Reef, Balabac I., Mar. 4, 1957; a collection by D. P. Abbott, on *Halimeda* sp., Pasig Bay, Balabac I., Mar. 3, 1957; a collection by Y. Kondo from a reef, Siasi I., northeast of Laminusa I., Jan 31, 1957; MALDIVE ISLANDS—Ha. 24–2L–132–3B, on *Pocockiella* sp., on a reef at a depth of 4 ft, Walla Faru I., South Nilandu Atoll, Apr. 24, 1964.

Algae of the above collections are structurally in close agreement with the description of *H. tenella* given by Falkenberg (1901) in most respects. Falkenberg reports 20–50 segments in the determinate branches. The writer was privi-

leged to examine a portion of a specimen from the Agardhian herbarium in Lund, which the Keeper, Dr. Sven Snogerup, concluded was the type of *H. tenella*, since it was annotated by J. G. Agardh as "Hutch tenella C. Ag. sp. orig." Examination of this material showed that the determinate branches were composed of about 15 segments. In other respects the material corresponds closely with Falkenberg's description.

H. tenella form *secunda* (C. Ag.) comb. nov.

Herposiphonia secunda (C. Ag.) Falkenberg (1901:307)

Hutchinsia secunda C. Agardh 1824:149

A number of collections are assigned to this variously interpreted taxon, differing from typical *H. tenella* chiefly in the occurrence of but 1 determinate branch between successive indeterminate branches, with 1–4 bare nodes following each indeterminate branch. HAWAIIAN ISLANDS—T. 934B2, 934C, on a reef near shore, Trig I., French Frigate Shoals, Sept. 27, 1964; JOHNSTON ISLAND—T. 1084C, 25 m inside the surf zone, outer reef, legit R. Buggeln, Aug. 19, 1965; LINE ISLANDS—L. 2708.4, tetrasporic, southwest reef, Jarvis I., Nov. 16, 1964; D. 20033.1, on other algae, legit Ralph F. Palumbo, northeast point of Christmas I., May 16, 1962; TUAMOTU ARCHIPELAGO—D. 11188.1, lagoon transect, Ngarumaoa, Raroia Atoll, legit M. S. Doty and Jan Newhouse, July 12, 1952; GILBERT ISLANDS—D. 18900.1, Abermama I., legit Jane Cooper, July, 1962; MARSHALL ISLANDS—G. 657.1, in the lagoon at a depth of 35 m, Eniwetok Atoll, Sept. 7, 1955; CAROLINE ISLANDS—D. 15559.3, on *Acanthophora*, Koror I., Palau group, legit Ernani Meñez, Sept. 5, 1960; PHILIPPINE ISLANDS—D. 18213B1, on *Acanthophora*, Mawes I., Hinatuan, Surigao, July 7, 1958; MALDIVE ISLANDS—Ha. 24–21–132–16B, on a reef at 4 ft, Walla Faru, South Nilandu Atoll, Apr. 24, 1964.

In some of the specimens listed above the determinate branches are somewhat larger, up to 80 μ in diameter, with 40 or more segments 1.5–2.0 diameters long, whereas Falkenberg (1901) states that in *H. secunda* the determinate branches are relatively plump, with 14–20 segments, which are mostly shorter than broad.

Through the kindness of Dr. Sven Snogerup,

Keeper of the herbarium, Lund University Museum, the writer was privileged to examine a specimen from the Agardhian herbarium, which Dr. Snogerup considers an isotype specimen of *H. secunda*. It is a glass slide mount, no. 39158, with the following notation on the original packet: "Hutchinsia unilaterale, Aug. 6, 1825, Tingi, Schousboe." This specimen exhibits the chief features described by Falkenberg (1901), with mostly 1 determinate branch and 2 bare nodes between successive indeterminate branches. The determinate branches are composed of 10–12 segments, with about 10 pericentral cells. The specimen is tetrasporic, with fruiting segments about 1 diameter long. The tetrasporangia are in series of 7–8 in the upper part of the branches. The lower sterile segments are 1.5–2.0 diameters long. The chromatophores do not seem to be zonate. There are about 3 terminal trichoblasts, with 6–8 dichotomies. They are about as long as the branch bearing them.

Fluid-preserved material from the type locality, northern Africa, would prove helpful in determining the correctness of the above identification.

Prof. J. Feldmann of Paris kindly sent the writer a collection of *Herposiphonia* from le Troc, Banyuls, France. He identified this alga as *H. secunda*. The specimens were fluid-preserved and in excellent fruiting condition, with an abundance of procarps and cystocarps. In most respects the plants of this collection matched the description of *H. secunda* given by Falkenberg. However, the segments of determinate branches of Feldmann's plants are mostly 1.5–(2) diameters long, as they are in a number of the collections from the Pacific listed above. The procarps arise apically or subapically, 2–3 per branch, but the branch continues to grow beyond the developing cystocarp for 8–10 segments.

Falkenberg (1901) and Boergesen (1918) both reported instances in which the branching pattern for *H. tenella* and that for *H. secunda* occurred on the same branch. The writer has observed similar instances not only in plants of the *H. tenella* type, but in other species as well. Hence it has seemed necessary to conclude, as did Boergesen at first, with some reservations, that *H. secunda* should be considered merely a form of *H. tenella*. The branching pattern seems

to be a good key feature for distinguishing between certain species, but it is an unreliable feature in this instance.

Herposiphonia trichia sp. nov.

Fig. 1G

Epiphytic algae, with prostrate branches about 45μ in diameter, attached by frequent rhizoids, and bearing 3 erect, slightly more slender, determinate branches 1–2 mm high, and composed of 10–16 segments, arising in alternating positions between successive indeterminate branches or branch rudiments, with no bare nodes, or sometimes with determinate and minute indeterminate branches at alternate nodes; pericentral cells 6–8 in indeterminate branches and lower parts of determinate branches, but occasionally reduced to 4 in the slender terminal parts of the latter; chromatophores not zonate; trichoblasts unbranched or occasionally with 1 or 2 laterals, up to 700μ long and about 8μ in diameter at the base, composed of 8–9 cells, gradually tapering to a rounded or conical tip, arising one per segment in $\frac{1}{4}$ spiral sequence in the terminal parts of the determinate branches, mostly soon deciduous, leaving relatively large scar-cells; tetrasporangia relatively large, 60 – 70μ in diameter, in straight series of 10–12–(16) in the much-distended lower half of the determinate branches; spermatangial stichidia arising from the entire trichoblast primordium, without a sterile tip, 1 or 2 per branch on short unicellular pedicels, on the convex side of the branch, 3–5 nodes from the base; procarps borne singly in similar positions; cystocarps not observed.

Algae epiphyticae, tres ramos determinatos inter ramos indeterminatos successivos habentes, nodis nudis nullis; cellulae pericentrales plerumque 6 in ramis indeterminatis atque in partibus inferioribus ramorum determinatorum, in partibus terminalibus tenuibus, autem, ramorum determinatorum ad 4 reductae; trichoblastae non ramosae aut interdum uno duobusve ramis lateralibus praediate, ad 700μ long., et c. 8μ diam. ad basim, ex 8–9 cellulis compositae, ad cacumen rotundatum gradatim attenuatae; una in unoquoque segmento spiraliter in partibus ramorum terminalibus orientes, plerumque mox deciduae, cellulas-cicatrices maiores reliquentes; tetrasporangia 60 – 70μ diam., 10–12 in serie recta in ramorum dimidio inferiore sita; stichidia spermatangialia e toto trichoblastae primordio, unum vel duo in unoquoque ramo determinato in latere convexo in nodo secundo ad quintum a basi posita, sine cacumine sterili; procarpi similiter orientes; cystocarpi non observati.

TYPE COLLECTION: D. 23461.1, tetrasporic, on *Amphiroa* sp., on a reef, Yap I., Caroline Islands, legit Ernani Meñez, Aug. 18, 1960. This collection is represented by two glucose slide mounts.

ADDITIONAL COLLECTIONS EXAMINED: D. 23466.1, spermatangial, on *Amphiroa* sp., along with the type collection; D. 23471.1, with procarps, on *Amphiroa* sp., from the same locality as the two preceding collections. This species resembles *H. hollenbergii* described by Dawson (1963:430) from the Pacific coast of Mexico. From that species it differs in the following respects: (1) decreasing size and number of pericentral cells in the upper parts of determinate branches, rather than increasing to 60 – 80μ and to 10–12 pericentral cells in the upper parts of determinate branches as in the Mexican plants; (2) the pattern of development of secondary indeterminate branches; and (3) the much longer unbranched trichoblasts, which are described by Dawson for *H. hollenbergii* as "short, sparse or absent." From *H. delicatula* the present species differs chiefly in the mostly unbranched trichoblasts.

Herposiphonia variabilis sp. nov.

Figs. 1F, 2G, 17, 18, 21

Saxicolous algae with prostrate branches 70 – 100μ in diameter, with segments 0.7 – 1.0 –(2.0) diameters long, with about 10 pericentral cells and with slightly inrolled apex, attached by frequent unicellular rhizoids; erect determinate branches 0.3 – 1.0 –(2.0) mm high at maturity, 70 – 80μ in diameter, composed of 10–16–(50) or more segments 0.6 – 1.5 diameters long, with 8–10 pericentral cells and a central cell up to twice as large as the pericentral cells; only 1 determinate branch between successive indeterminate branches, each indeterminate branch being followed distally by (0)–1–6 bare nodes; indeterminate branches usually not extensive; chromatophores commonly zonate; trichoblasts 3–4–(9) per erect branch, with only 2–3 present at one time, the first-formed one as much as 10 segments from the ultimate branch apex; trichoblasts up to 2.5 mm long, with 4–6 dichotomies and gradually narrowed to delicate tips, the basal cell frequently 200 – 350 –(730) μ long and 40 – 45 –(58) μ in diameter at maturity;

trichoblasts with about $\frac{1}{3}$ spiral divergence, at intervals of 1–5 segments, soon deciduous, leaving large scar-cells and commonly prominent wall-scars; tetrasporangia 40–50 μ in diameter, in straight series of (6)–13–24, in terminal parts of the branches; cystocarps subterminal, 350 μ in diameter, ovate, with a prominent ostiolar beak; spermatangial stichidia slightly lanceolate, 160–200 μ long and 60–65 μ in diameter, on a short 1-celled pedicel, and with a short 1-celled sterile apex, arising terminally from the entire trichoblast primordium.

Algae saxicolae ramos prostratos ad 100 μ diam. qui ramos determinatos erectos 0.5–1.0–(2.0) mm alt. et 70–80 μ in diam., e 7–15–(30) segmentis 0.6–1.5 plo longioribus quam latis compositos, ferunt, cellulis pericentralibus 8–10, habentes; 1–5 nodi nudi inter ramos indeterminatos successivos plerumque semper breves, unicum ramum consequentes; chromatophora vulgo zonata; trichoblastae 3–4–(9) in unoquoque ramo erecto, 2–3 semel, trichoblasta primum formata usque ad segmentum decimum ab apice rami sita; trichoblastae usque ad 2.5 mm long., 4–6 dichotomias habentes, ad cacumina tenuia gradatim attenuatae, intervallis 1–3 segmentis spiraliter ordinatae, mox deciduae, magnas cellulas-cicatrices reliquentes; tetrasporangia 40–50 μ diam., in partibus ramorum terminalibus sita; cystocarpi subterminales, c. 350 μ diam., ovati, rostro ostiolarum conspicuo praediti; stichidia spermatangialia sublanceolata, 160–200 μ long., 60–65 μ diam., apicem sterilem unicellularem brevemque habentia, in parte extrema ramorum determinantorum orientia, e primordio toto trichoblastae formata.

TYPE COLLECTION: H. 65–113, tetrasporic, cystocarpic, spermatangial, on dead coral at a depth of 1–2 m and 20 m shoreward from the outer reef margin north of North I., Johnston Island, legit R. S. Jones, April 22, 1965. This collection is represented by 7 glucose slide mounts and additional fluid-preserved material.

ADDITIONAL COLLECTIONS EXAMINED: HAWAIIAN ISLANDS—D. 22533.1, in algal turf, near Honokohau, Maui, legit H., T., and B., April 20, 1965; JOHNSTON ISLAND—T. 1068, 1069A, on dead coral, legit R. Buggeln and Earl Murchison, Aug. 17, 1965; T. 1351.1, tetrasporic, on dead coral, at a depth of 3.3 m, north-east of North I., inside of wave-break zone, legit R. Tsuda and R. Buggeln, Nov. 18, 1965; LINE ISLANDS—L. 2705.3, tetrasporic, with unusually long determinate branches, in surge channel of

reef flat, Jarvis I., Nov. 16, 1964; D. 20029, northeast point of Christmas I., legit Ralph Palumbo, June 3, 1962; TUAMOTU ARCHIPELAGO—D. 11160.6, on dead coral, coral reef near passageway, Raroia Atoll, legit M. S. Doty and Jan Newhouse, July 9, 1952; MARSHALL ISLANDS—H. 48–0914.30, tetrasporic, outer reef, Uku I., Bikini Atoll, July 9, 1948.

This is a very variable species as to number of bare nodes, degree of development and number of trichoblasts, and the number of segments in the determinate branches. As many as 75 were counted in L. 2705.3. In some instances the large number of segments seems to be due to renewed growth of the branch. Determinate branches occasionally develop one or more laterals which may be either determinate or indeterminate. Although procarps arise subterminally, mature cystocarps may be as much as 10 segments from the branch apex, as a result of continued growth of the branch.

H. variabilis is probably closest to *H. tenella* form *secunda*, from which it differs chiefly in the following respects: (1) the greater variability in the number of segments in the determinate branches (Falkenberg [1901] reports 14–20 segments for the European specimens examined); (2) the great length of the trichoblasts in some specimens; and (3) the more numerous tetrasporangia in many cases.

REFERENCES

- AGARDH, C. A. 1824. *Systema Algarum*. Lund. xxxviii + 312 pp.
 ——— 1828. *Species Algarum* 2(1):i–lxxvi + 189 pp. Gryphiae.
 BOERGENSEN, F. 1915–1920. The marine algae of the Danish West Indies. III. Rhodophyceae. *Dansk Bot. Arkiv*. 3(1):1–504.
 DAWSON, E. Y. 1956. Some marine algae of the southern Marshall Islands. *Pacific Sci.* 10(1): 25–66.
 ——— 1963. Marine red algae of Pacific Mexico 8. Ceramiales: Dasyaceae, Rhodomelaceae. *Nova Hedwigia* 6:401–481.
 FALKENBERG, P. 1901. Die Rhodomelaceen des Golfes von Neapel. *Fauna und Flora des Golfes von Neapel*, Monograph 26. Berlin. vii + 754 pp.

- GARDNER, N. L. 1927. New Rhodophyceae from the Pacific Coast of North America, VI. Univ. Calif. Publ. Bot. 14(4):99-138.
- HARVEY, W. H. 1853. Nereis Boreali-Americana. II. Rhodospermae. Smithson. Contr. Knowledge 5(5):1-258.
- HOLLENBERG, G. J. 1943. New marine algae from southern California. II. Am. J. Bot. 30(8):571-579.
- 1968. An account of the species of *Polysiphonia* of the central and western tropical Pacific Ocean. I. Oligosiphonia. Pacific Sci. 22(1):56-98.
- KUETZING, F. T. 1843. *Polysiphonia* sect. *Herposiphonia*. Phycologia Generalis. Leipzig. Pp. 1-458, 80 pls.
- NÄGELI, C. 1846. *Herposiphonia*. Z. wiss. Bot. 1(3/4):238-256, pl. VIII.
- OKAMURA, K. 1899. Contributions toward a knowledge of the marine algae of Japan, III. Bot. Mag. Tokyo 13:2-11.
- SCHMITZ, F. 1889. Systematische Übersicht der bisher bekannten Gattungen der Florideen. Flora 72:435-456.
- SEGI, T. 1954. The new species of *Herposiphonia* from Japan. J. Fac. Fish., Mie Prefecture Univ. 1(3):365-371.
- SETCHELL, W. A. 1926. Tahitian algae and Tahitian Spermatophytes. Univ. Calif. Publ. Bot. 12(5):61-143.
- SETCHELL, W. A., and N. L. GARDNER. 1930. Marine algae of the Revillagigedo Islands Expedition. Proc. Calif. Acad. Sci., IV. 19(11):109-215.
- SMITH, G. M. 1944. The Marine Algae of the Monterey Peninsula. Stanford Univ. Press. Stanford, Calif.
- TAYLOR, W. R. 1960. Marine Algae of the Eastern Tropical and Subtropical Coasts of the Americas. Univ. Michigan Press, Ann Arbor. ix + 870 pp.
- TSENG, K. T. 1944. Marine algae of Hong Kong. V. The genus *Herposiphonia*. Papers Michigan Acad. Sci. Arts and Letters 29:55-65.
- TSUDA, R. T. 1964. Floristic report on the marine benthic algae of selected islands in the Gilbert group. Atoll Res. Bull. 105:1-13.